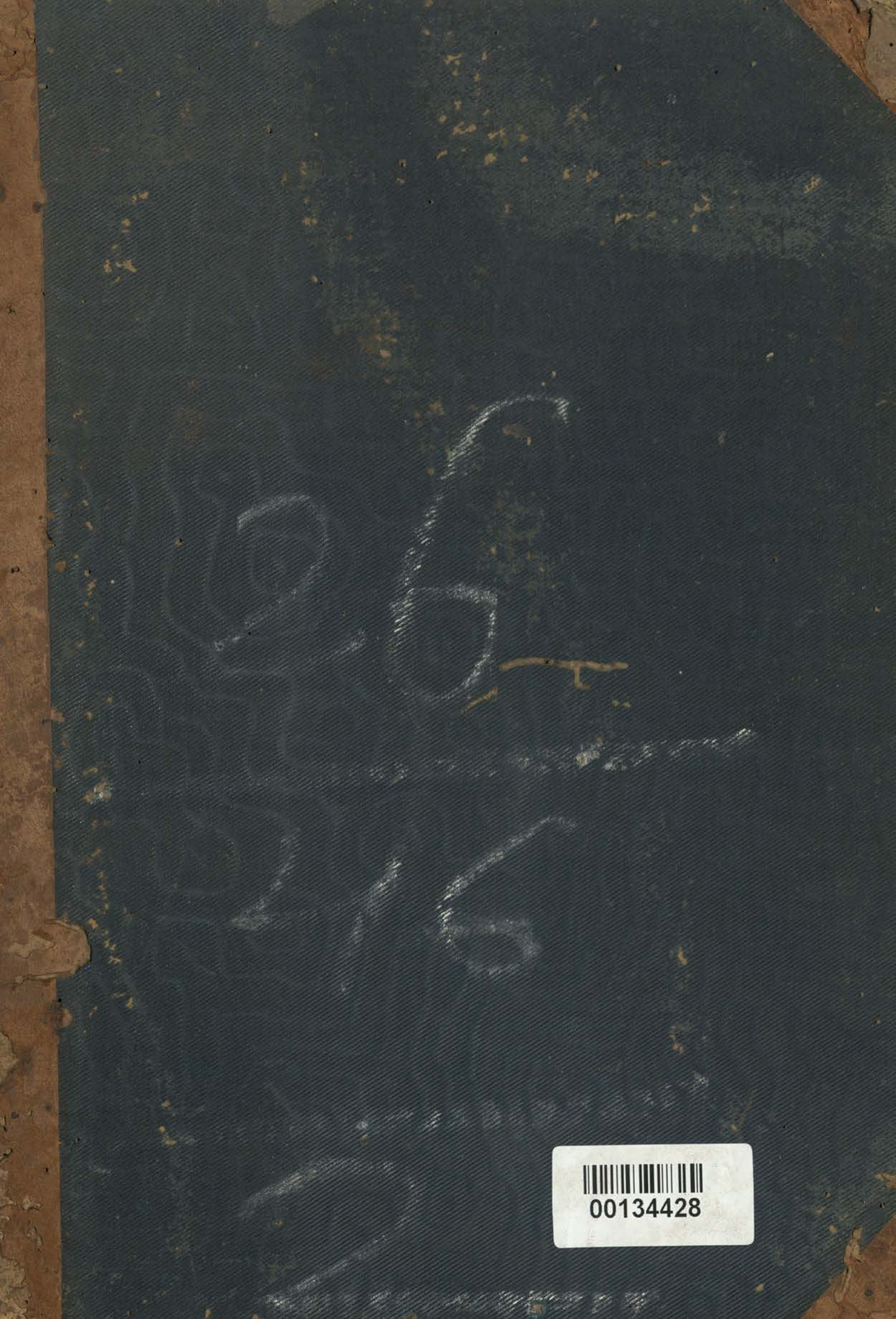
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Indian Meteorological Memoirs:

BEING

OCCASIONAL DISCUSSIONS AND COMPILATIONS OF METEOROLOGICAL DATA

RELATING TO

INDIA AND THE NEIGHBOURING COUNTRIES.

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Published by order of His Excellency the Viceroy and Governor-General of India in Council,

UNDER THE DIRECTION OF

HENRY F. BLANFORD, F.R.S.,
METEOROLOGICAL REPORTER TO THE GOVERNMENT OF INDIA.

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CORRIGENDA

IN VOL. II OF THE INDIAN METEOROLOGICAL MEMOIRS.

Page 105, Table I, STATION LEH, heading of 10th column, *for* "a periodic" *read* "aperiodic."
„ 106, „ „ „ RANIKHET, Mean daily range, December, *for* 15·°6 *read* 15·°9.
„ 108, „ „ „ AJMERE, Mean daily range, January, *for* 32·°4 *read* 30·°4.
„ „ „ „ „ „ „ „ „ February, *for* 31·°2 *read* 31·°1.
„ 110, „ „ „ JHANSI, Mean daily range, February, *for* 26 °6 *read* 25·°6.
„ „ „ „ „ „ „ „ „ Year, *for* 23·°3 *read* 23·°2.
„ 111, „ „ „ ALLAHABAD, Self-registered minimum, May, *for*—14·°0 *read*—13·°0.
„ „ „ „ „ „ „ „ „ Year *for*—10·°5 *read*—10·°4.
„ „ „ „ „ „ Mean daily range, May, *for* 28·°6 *read* 27·°6.
„ „ „ „ „ „ „ „ „ Year, *for* 23·°7 *read* 23·°6.

Pages 112, 121, and 131. *Substitute the following for the corresponding columns in the text.*

STATION HAZARIBAGH.

	PAGE 112, TABLE I.		PAGE 121, TABLE III—C.		PAGE 121, TABLE III—D.	
	10 hours.	10 hours.	For	Read	For	Read
	For	Read				
January	+ 1·5	+ 4·9	— ·01	— ·06	0	— ·03
February	+ 1·6	+ 4·2	0	— ·06	0	— ·03
March	+ 3·0	+ 5·5	0	— ·03	+ ·01	— ·01
April	+ 2·5	+ 5·3	0	— ·03	+ ·01	— ·02
May	+ 2·0	+ 4·8	+ ·02	— ·02	+ ·03	0
June	+ 1·3	+ 3·5	+ ·04	— ·01	+ ·02	— ·01
July	+ 0·6	+ 1·9	+ ·05	+ ·01	+ ·02	— ·01
August	+ 1·0	+ 1·9	+ ·05	+ ·02	0	0
September	+ 1·3	+ 2·8	0	— ·04	+ ·02	— ·01
October	+ 2·9	+ 4·7	— ·02	— ·06	0	— ·03
November	+ 3·3	+ 5·3	— ·02	— ·05	0	— ·03
December	+ 2·0	+ 5·0	0	— ·05	0	— ·03
Year	+ 1·9	+ 4·1	...	...	...	...

Page 114, Table I, STATION PACHMARHI, Mean daily range, January *for* 24·°3 *read* 24·°2.
„ „ line 3, from foot *for* "inner" *read* "outer."
„ 115, line 5, *for* "the maximum" *read* "the time of maximum."
„ „ line 19, *for* "year" *read* "years."
„ „ „ II, insert corrected daily ranges as above given for Ranikhet, Ajmere, Jhansi, Allahabad and Pachmarhi.
„ 118, line 9, after "*plains*" insert "*with the doubtful exception of Pachbudra.*"
„ „ line 22, *for* 34° *read* 37°.
„ 119, „ IIIA, STATION LEH, column headed July, *for* —·0 *read* —·07.
„ „ „ „ „ ALLAHABAD, May, *for* —·01 *read* —·03.
„ 120, „ IIIC, „ „ May, *for* —·03 *read* —·04.
„ 124, „ IV, column headed "PLACE" *for* "Nougaon" *read* "Nowgong."
„ 135, „ IX, line 2, column headed "YEAR" *for* 27·7 *read* 2·77.
„ 140, „ XII, *for* "Jhalrapatam" *read* "Jhalrapatan."
„ 142, line 9 from foot *for* 54·°4 *read* 52·°2; *for* 19° *read* 21°.
„ 143, line 16, *for* "four" *read* "two."

ADDITIONAL CORRIGENDA

IN VOL. I.

Page 178, Table IX, hour midnight, column headed "July" *for* + 17 read +·017.
" " " " " " " " "August" *for* +0·18 read +01·8.
" 324, " VI, " 22 , " " "October difference" *for* + 0·11 read + ·011.
" 328, line 13, *for* $(U''\div U')$ *read* $(U''\div U)$.
" 329, Table XII, line 9, column headed "February" *for* ·011 *read* +·011:
" " " " " " " " "July" *for* ·006 *read* +·006.
" " " " " " " " "August" *for* ·012 *read* +·012.
" 332, line 4, *for* "mindle" *read* "middle."
" " " 39 *for* "especially" *read* "especially."
" 334, In Table, line 7, column headed "September" *for* ·899 *read* ·899.
" 366, line 17, *for* 279 *read* 179.
" 369, Table X, hour 9, column headed "January" *for* +·067 read +·0679.
" 372, Table XIII, hour 5, column headed "January diff." *for* +·01 *read* +·001.

I.—*Account of the South-West Monsoon Storm of the 18th to the 24th of September 1878 in the North of the Bay of Bengal, by* JOHN ELIOT, ESQ., M.A., *Meteorological Reporter to the Government of Bengal.*

THE following account of a brief cyclonic storm, which was generated near the head of the Bay and passed over Central Bengal in the third week of September 1878, has been compiled as a commencement of the work of discussion of the minor storms of the Bay of Bengal.

The extensive storms, usually called cyclones, are of comparatively rare occurrence, more especially in the northern half of the Bay. The smaller storms, of which the present is, I believe, a typical example, are very common during the rains; several, of greater or less intensity, occurring, each year, during the months of June, July, August, September and October.

The materials for the discussion of this storm were collected by Mr. Alexander Pedler, who was acting for me as Meteorological Reporter to the Government of Bengal, at the time the storm happened. They are not very large in amount, and many of the observations, more especially those of the barometer taken on board several of the ships, are quite untrustworthy, and do not admit of any treatment which will render them of much value for the purpose of comparison. This is, I fear, apparently due to the use, on board many ships, of barometers that are, from one cause or another, almost utterly useless; and it seems to me a matter worthy of consideration by those interested in the question, whether the occasional comparison of ship barometers with a standard barometer, at such ports as Calcutta, is not almost as desirable and even essential for successful navigation, as the testing and comparison of compasses and chronometers.

I have, however, endeavoured to utilize the meteorological information contained in the logs, to the utmost extent compatible with the doubtful character of many of the observations, I have, necessarily, made them supplementary to the meteorological data, supplied by the land observatories in Northern India.

Conditions of formation of cyclonic storms of the South-West Monsoon.—I have already stated, in the Backergunge and Madras Cyclone Reports, what I believe to be the usual atmospheric conditions which precede and accompany the formation, development and motion of a storm centre or cyclonic vortex in the Bay of Bengal, during either of the transition periods. In the Madras Cyclone Report and in the Report on the Meteorology of India for the year 1877 I have also indicated the conditions and characteristics of the minor cyclone storms of the south-west monsoon, from the brief examination permitted by the ordinary observations, taken at the meteorological stations on the coast of the Bay of Bengal. The chief feature of the weather, during the rains in Northern India, is the intermittent distribution of the rainfall, or the apparently oscillatory character of the monsoon current. A fall of the barometer in Northern India is rapidly followed by and associated with an increased inrush of the monsoon current, giving a copious rainfall for several days. The barometer generally rises with the continuation of the rainfall. The current diminishes in intensity; and finally the rainfall, instead of being

general in character, is reduced to occasional local showers. Usually, after a few days of this condition of affairs, the barometer again falls in Northern India, and the same succession of phenomena is again observed. The period of diminishing rainfall, or of more local rainfall in these oscillatory atmospheric movements, forms what is usually termed a "break in the rains." At these periods, the baric differences over Upper India are generally small and the winds light. As the monsoon, further south, still blows with its average intensity, these periods (if the principles laid down and established in my previous Cyclone Reports be correct) occasionally present conditions in the Bay favourable to the formation and development of a cyclonic storm and vortex. The great majority (if not all) of the minor storms, which have occurred in the past four years, during the prevalence of the south-west monsoon, have originated during these short intervals known as *breaks* in the rains. The storms form rapidly near the head of the Bay, and travel directly to the coast, either of Orissa or Bengal, passing into the interior, and bringing with them copious rainfall. They gradually disappear, their existence being generally conterminous with the heavy rainfall over the land area which marks their progress. The present case has been selected for discussion, mainly because the materials are more abundant and complete than are usually obtained, and partly because it is, in every important feature, a typical example of an ordinary cyclonic storm of the south-west monsoon period, or of what I propose to call in future a *south-west monsoon* or *rainy-season storm*.

General features of the meteorology of India, 1878.—The meteorology of the year 1878 was in many respects somewhat abnormal. The south-west monsoon rains set in rather later than usual; and the current, judged by the amount and distribution of the rainfall, was below its average strength. The rains were also unusually late in establishing themselves in Upper India. One very marked feature, during the year, was the tendency to excessive local falls of rain.

The following extract from the Report on the Meteorology of India, for the year 1878, states these characteristics of the monsoon rains of that year very clearly:—

"On the clearing of the atmosphere at the end of May, dry hot westerly winds set in over the Upper Provinces, as is usually the case after heavy precipitation on the Himalaya in the spring months; and the usual monsoon rains were deferred until quite the end of June or the beginning of July. The temperature was excessive, and for the first time for many months, the pressure of the North-Western Provinces fell slightly below the average. It still remained, however, excessive in most parts of Northern India, but in the Peninsula and Ceylon the excess had now disappeared. In July and August, indeed, it again became excessive in Northern India, but not in the south; and, after that month, all excess finally vanished, and during the last months of the year an abnormal depression prevailed everywhere. The persistence in July and August of an excess of pressure in Northern India, and in Assam and Arakan, while in Southern India and Ceylon it had fallen below the average, tended, in accordance with the well-known law of the winds, to strengthen the southerly monsoon wind of the Bay of Bengal and the easterly winds of Northern India. This effect was very strongly marked; but the same distribution was antagonistic to the Bombay branch of the monsoon, which, accordingly, was weaker than usual. As the greater part of the rain of Northern India is brought as vapour by the wind from the west coast, the consequence of this weakening of this branch of the mon-

soon was a deficiency of the usual fall in many provinces, and especially in the eastern part of Central India, and the neighbouring districts of the North-Western Provinces. But in the provinces nearer the west coast, *viz.*, the Konkan, Guzerat, and the Deccan, and more especially the second, the precipitation was extraordinarily copious."

The breaks in the rains were also rather more numerous than usual, and these were, in the majority of cases, attended with the formation of small cyclonic storms near the head of the Bay. Two-thirds of these storms, as shown by the following list, advanced north-westwards across the coast of Orissa.

The following is a list and brief account of all the atmospheric whirls or cyclones which formed in the Bay during the prevalence of the south-west monsoon of 1878, and advanced across the north or west coasts of the Bay. There is some evidence of the existence of two or three more atmospheric whirls during this period, but they are not included, as they do not appear to have reached the coast. The account of each of these storms is extracted from the weekly weather report published during the south-west monsoon of 1878 at Simla by the orders of the Government of India.

I.—Cyclonic or South-West Monsoon Storm of the 19th to the 27th July 1878.

This storm began to affect the pressure along the west coast of the Bay on the 19th. The pressure at Vizagapatam diminished more rapidly than at the other coast stations, and continued unusually low until the 22nd, when the storm centre reached the coast of Ganjam to the north of Vizagapatam. The centre advanced to the north-west, past Cuttack.

The advance of this disturbance gave very heavy rain to the coast region, from Vizagapatam to Masulipatam; 5·6 inches fell during the 24 hours preceding 10 A. M. of the 23rd at Vizagapatam, and 4·5 inches at Masulipatam.

The combination of this area of low pressure to the west of Orissa, and of the permanent low pressure in North-Western India (Sind, the Punjab and Rajputana) on Friday (July 26th), gave rise to a continuous belt or trough of low pressure extending from the coast of India to Upper Sind. The chief meteorological feature of the next few days was the gradual contraction of this trough of low pressure westwards. On Saturday (July 27th) the pressure was absolutely lowest at Jubbulpore; on the 28th and 29th it was lowest at Ajmere, and on the 31st it was lowest at Jacobabad. Strong winds were prevalent during this period, both to the north and south of the trough of low pressure. On the other hand the winds at the stations situated in the trough of low pressure were light. In the North-Western Provinces the winds were from two to three times their normal strength. The gale of wind, in this area, began on Friday, and lasted until Monday.

The indraught, due to it, gave rain to the whole of Northern India. The heaviest and most extensive falls occurred on the south-eastern and eastern edges of the trough of low pressure. Its retreat to North-Western India (the area of permanent low pressure at this period), on the 31st of July and 1st of August, was accompanied by a diminution of wind velocity in Northern India, and by general rain in Upper India.

The rain, due to the indraught towards this area of low pressure, was especially valuable, as it fell chiefly in South-Western Bengal, Orissa, the North-Western Provinces, the Punjab and Sind; in all of which districts, the rainfall had hitherto been very consid-

erably below the average. It also, in consequence of the indraught to Northern India, gave a partial break in the rains to Northern Bengal and to the Deccan and Madras, where the rainfall had previously been excessive in amount.

II.—Cyclonic or South-West Monsoon Storm of the 1st to the 4th of August 1878.

This storm was developed on the 1st and 2nd at the head of the Bay. It reached the coast of Orissa on the morning of the 3rd, when it occupied a well-defined area, oval in shape; on the 4th there was a belt of low pressure stretching from Orissa to Sind. The pressure was lowest on the morning of that day at Jubbulpore and Allahabad; which stations may be described as occupying the lowest portion of the trough. The winds on the western quadrant were comparatively feeble, but after the disturbance had reached Orissa, strong southerly and easterly winds set in over Bengal and Behar and gave heavy rain.

III.—Cyclonic or South-West Monsoon Storm of the 6th to the 8th of August 1878.

On the 5th the Allahabad and Jubbulpore area of low pressure of the previous day disappeared and the trough filled up. The chief consequence of this was marked uniformity of pressure, on the 5th and 6th, over Northern India. Another whirl, as indicated by the wind directions on the morning of the 6th, at the coast stations of Orissa and Bengal, was forming, on that day, in the north-west angle of the Bay. It reached the Balasore coast on the morning of the 7th, and gave rise, on the 8th, to a trough of low pressure, stretching from Chutia Nagpore to Upper Sind; deepest at the two stations of Jubbulpore and Allahabad.

The rain, during these two storms, was especially valuable, as it occurred to a somewhat larger amount over those districts which had previously received deficient rainfall, *viz.*, Burmah, South-Western Bengal, Orissa, the North-Western Provinces, Bundelkhand, Gwalior, and the eastern districts of the Punjab.

IV.—Cyclonic or South-West Monsoon Storm of the 11th to the 13th of August 1878.

This was a very small depression, and is only noticed in the weekly reports, as influencing the winds over the west coast of the Bay of Bengal, and as being accompanied with moderate rain. It advanced across the Ganjam coast, and almost immediately afterwards disappeared.

V.—Cyclonic or South-West Monsoon Storm of the 20th to the 22nd of August 1878.

This was similar, in every respect, to the previous storm in character and position. It also gave very moderate rain along the mid-west coast.

VI.—Cyclonic or South-West Monsoon Storm of the 14th to the 19th of September 1878.

The barometer, which was below the average height in Northern India, began to rise on the 13th; pressure increased rapidly in Northern India, until the morning of the 15th. During this interval, heavy rain appears to have fallen at the head of the Bay, and it determined the origin of a feeble cyclonic disturbance. It reached the coast of Orissa on the morning of the 15th. At 10 A.M. of the 15th, the centre was in the neighbourhood of Cuttack. The rainfall which accompanied it, at this time, was moderate in amount. It advanced almost due westwards, and the cyclonic vortex was between Jubbulpore and Nagpore on the morning of the 17th. Here it began to draw supplies of

moisture from the west coast of India. The rainfall in the Central Provinces was much more considerable than the rainfall in Orissa, during the passage of the cyclone. With the continued indraught from the Arabian Sea, the cyclonic vortex advanced westward, and became further intensified. On the morning of the 17th the vortex was near Khandwa; and, on the 18th, in the neighbourhood of Surat. The rainfall, over a large portion of the area, including these stations, was excessive on the 17th, 18th and 19th. The unusual line of march of this cyclonic depression across the head of the peninsula proper, and the further development of the disturbance, after the supply of moisture from the Bay of Bengal (as shown by the Orissa rainfall) was failing, was evidently due to the heavy local rainfall over the middle and lower valleys of the Nerbudda and Tapti.

VII.—Cyclonic or South-West Monsoon Storm of 17th to the 23rd of September 1878.

On the morning of the 19th the existence of this cyclonic storm was shown by low barometer at Akyab, and by a moderate indraught from Bengal to the Bay. The centre was off the coast, between Chittagong and Akyab, on the morning of the 20th. The winds were very light round the coast; and the rainfall, on the coast of Burmah and Arakan, moderate; and, at this time, the vortex appeared to be filling up. The rainfall appears to have increased in amount during the day; and, on the morning of the 21st, the vortex was a short distance to the south-east of Saugor Island. The winds at the coast stations, more especially those of Burmah and Arakan, were now rapidly increasing in strength. During the day the cyclonic disturbance increased in intensity, with the occurrence of heavy rainfall, and crossed the Sunderbunds in the direction of Calcutta. The cyclonic vortex was in the immediate neighbourhood of that station, on Sunday morning (the 22nd), and to the east of it. Very heavy rain occurred, on the morning of that day, at Calcutta and in the adjacent districts. It continued to drift slowly to the north-north-west, and the centre, at 10 A.M. of the 23rd, was about midway between Calcutta and Purneah. Strong winds had set in with the passage of the cyclonic vortex across the Sunderbunds; and a gale of wind prevailed, on the 22nd and 23rd, over the whole of Southern and Eastern Bengal, and in Western Assam. On the morning of the 24th the cyclonic vortex was in the immediate neighbourhood of Purneah. Strong winds continued over the same area as on the previous day. The vortex, however, rapidly filled up during the day, and completely disappeared before the morning of the 25th; on which day, calms and light winds were reported from all the Bengal and Assam stations.

VIII.—Cyclonic or South-West Monsoon Storm of the 4th to the 6th of October 1878.

This was a much smaller disturbance than the two previous storms. The depression of the barometer was small in amount. The wind directions in Bengal indicated its presence on the 4th. It advanced northward, and across the Bengal coast east of Saugor Island on the 6th, and filled up on the 7th after having given heavy rain to Eastern Bengal.

IX.—Cyclonic or South-West Monsoon Storm of the 13th to the 16th of October 1878.

This was formed off the Coromandel Coast. Its existence was shown by the wind directions, on the west coast of the Bay, on the morning of the 14th. It was of no great intensity, and reached the coast, probably on the morning of the 16th, and disappeared

almost immediately afterwards. It gave very heavy rain to the coast from Vizagapatam southwards to Madras.

X.—Cyclonic or South-West Monsoon Storm of the 28th to the 31st of October 1878.

Pressure was singularly uniform, on the 25th, over the whole of India, and this was accompanied by light variable winds and calms. On the 26th, the barometer began to rise in Upper India, and increased steadily until the morning of the 29th; when the distribution of pressure was that, usually characteristic of the cold weather. With the increase of pressure in Upper India, north and north-easterly winds set in over Burmah, Arakan, Bengal, Central India, the Central Provinces, while westerly winds prevailed in the Punjab, the North-Western Provinces and Behar.

On the morning of the 28th the first indications of the formation of a cyclonic disturbance were presented by the observations at the coast stations of the Bay. Pressure began to fall rapidly along the Coromandel Coast, and the wind directions indicated a strong indraught to an area of diminishing pressure in the centre of the Bay.

The disturbance presented a very striking similarity to the last mentioned disturbance. Both were formed immediately after the occurrence of almost uniform pressure. Both were generated off the same part of the coast, and gave heavy rain, over very nearly the same area; and finally, both appear to have been nearly stationary disturbances.

The present disturbance gave very heavy rain to the coast of Orissa and the Circars on the 28th and 29th, and moderate rain on the 30th and 31st. Rain fell during its existence at all the coast stations from Rangoon to Colombo, with the exception of Madras.

HISTORY OF THE SOUTH-WEST MONSOON STORM OF THE BAY OF BENGAL OF THE 18TH TO THE 24TH SEPTEMBER.

THE following pages deal with the seventh of the south-west monsoon storms of 1878.

Meteorology of India from the 12th to the 16th of September.—On the 12th and 13th of September excessive rain had fallen over a small portion of the Rohilkand division of the North-West Provinces; Bareilly received on the 12th 7·64 inches. On the 13th and 14th the rainfall in Upper India was small in amount and local in its distribution. At this time a small storm was formed and developed near the head of the Bay (No. 6 in the list), which crossed the Orissa Coast on the morning of the 14th. It gave moderate rainfall to Orissa, and advanced westwards across the Central Provinces. Here, apparently, it drew moisture from the Bombay branch of the monsoon current, and gave heavy rainfall over the Central Provinces on the 15th. This prolonged the existence of the barometric depression, and it continued to advance towards the west; (a very unusual course). It included the lower and middle valleys of the Nerbudda and Tapti, on the morning of the 17th; the centre, at 10 A.M. of the 17th, was probably in the neighbourhood of Indore and Khandwa. Very heavy rainfall occurred over this area. Indore, for example, received 10·15 inches on the 16th.

Meteorology on the 17th of September (Vide Plate I.)

Meteorology of India on the 17th of September.—The main feature in the meteorology of India, on the 17th, was the prolonged existence of the barometric depression in Western India. The chart of the 17th shows a well-marked cyclonic circulation over the whole of Northern and Central India, due to this vortex. The winds in Northern India were generally of moderate strength, whilst they were above their normal intensity along the Bombay Coast and in the Central Provinces.

Meteorology of the Bay of Bengal and the adjacent coast area on the 17th of September.—The following table gives observations taken at stations in Bengal and over the coast area of the Bay on the 17th of September:—

STATIONS.	Barometer, 10 A.M.	Barometer reduced to sea-level.	Change since previous day.	WIND DIRECTION.		Mean direction of wind for September.	WIND VELOCITY.			Amount of cloud, 10 A.M.	Rainfall.
				10 A.M.	4 P.M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Nancowry . . .	29·808	29·888	—·041	WSW	WSW	S 52° W	312·3	241·0	130·0	7	0·28
Port Blair . . .	29·774	29·837	—·038	W	WSW	S 40° W	443·0	235·6	188·0	10	2·45
Diamond Island . .	29·747	29·789	—·060	W	WNW	S 43° W	276·3	167·0	165·4	8	3·63
Akyab	29·703	29·724	—·089	E	W	S 7° E	52·0	70·3	73·9	6	0·01
Chittagong . . .	29·634	29·723	—·061	SW	WSW	S 27° E	50·2	109·2	46·0	3	...
Dacca	29·675	29·710	—·043	S	Calm	S 78° E	85·0	115·0	73·9	3	...

Stations.	Barometer, 10 A.M.	Barometer reduced to sea level.	Change since previous day.	Wind direction. 10 A.M.	Wind direction. 4 P.M.	Mean direction of wind for September.	Wind Velocity. Number of miles previous 24 hours.	Wind Velocity. Average for past years.	Wind Velocity. Ratio of amount of wind to average amount expressed as a percentage.	Amount of cloud, 10 A.M.	Rainfall.
Jessore	29·659	29·692	—·044	ESE	E	S 23° E	63·6	79·0	80·5	6	0·31
Berhampore	29·621	29·687	—·045	ESE	ESE	S 45° E	83·5	86·4	96·6	6	...
Silchar	29·627	29·715	—·081	WNW	W	S 49° W	31·9	64·9	49·2	7	...
Goalpara	29·335	29·717	—·039	Calm	Calm	S 68° E	39·7	90·8	43·7	0	...
Sibsagar	29·411	29·740	—·054	Calm	Calm	N 62° E	16·5	61·8	26·7	10	...
Purneah	29·564	29·688	—·04	SE	E	S 79° E	78·0	63·0	123·8	3	...
Durbhanga	29·531	29·697	—·037	ESE	E	S 87° E	111·7	91·8	121·7	5	...
Patna	29·492	29·670	—·039	E	E	S 84° E	35·1	62·5	56·2	6	0·16
Gya	29·279	29·655	—·038	E	E	S 78° E	60·0	54·8	109·5	6	0·20
Hazaribagh	27·660	29·654	—·033	F	E	S 57° E	230·9	168·7	136·9	9	0·25
Burdwan	29·580	29·679	—·042	ESE	E	S 30° E	81·5	80·9	100·7	7	0·02
Calcutta (Alipore)	29·655	29·676	—·041	E	SE by E	S 27° E	111·0	121·7	91·2	6	0·45
Saugor Island	29·664	29·670	—·044	SE	SSE	S 8° W	189·7	221·2	85·7	3	0·08
False Point	29·633	29·648	—·030	W	Calm	S 32° W	124·6	167·1	74·6	8	1·06
Cuttack	29·570	29·650	—·014	WSW	NE	S 7° W	28·7	61·2	46·9	5	0·18
Vizagapatam	29·682	29·714	+·024	NW	W	N 83° E	73·2	56·3	130·0	10	...
Masulipatam	29·734	29·744	+·008	W	...	N 58° W	...	...	...	4	...
Madras	29·793	29·815	—·021	SW by W	...	S 31° W	189·0	157·9	120·0	5	...

The preceding observations show fully the general character of the weather round the coast of the Bay, and in Bengal, Assam and Behar. The barometer was falling at this date at the great majority of stations. This, however, was only a portion of the general oscillatory movement of the barometer, which forms a very marked feature in Indian Meteorology. Such a fall may be of no significance whatever; or it may, as perhaps in the present case, be more prolonged and of greater amplitude than the ordinary oscillations, and hence be due to some considerable atmospheric change coextensive with the whole Indian area. It is not necessary, for the purposes of the present investigation, to separate the barometric changes into the two parts, *viz.*, the change due to the regular oscillations of short period, and the changes due to abnormal actions and atmospheric conditions. In the south and south-east of the Bay the winds were considerably above normal strength. This was especially the case at Port Blair, where they were 88 per cent. above their average force. In Chutia Nagpore and Behar they were also slightly in excess of their average intensity. In Arakan, Bengal, Assam and Orissa they were, on the other hand, light, and very considerably below their average strength. This feature was most marked in Assam, and to a less extent in Orissa and South-Eastern Bengal. At the Assam stations the winds averaged only forty per cent. of their normal strength in September. The variability of the wind directions at several of the stations, more especially those in Eastern Bengal and Arakan (as for example Akyab, where the wind was from the east at 10 A.M. and from the west at 4 P.M.) indicates the commence-

ment of a period of light and variable winds and calms in this portion of the Indian area. The wind directions and velocities generally show that, in the south and centre of the Bay, strong monsoon winds, with a more pronounced westerly element than usual, were blowing. In Bengal, Behar and Chutia Nagpore, the winds were nearly normal in direction, and indicated the continuance of the ordinary monsoon easterly current up the Gangetic valley.

Moderately heavy rain fell at Port Blair and Diamond Island; the former registering 2·45 inches, and the latter 3·4 inches. Light showers fell at the majority of stations in Orissa, Behar and Chutia Nagpore. The largest amount, given in the table is 1·06 inches at False Point.

The following table gives the average rainfall in the various divisions of Bengal, calculated in the usual manner, as an arithmetical mean of the amounts registered at the revenue stations which record rainfall:—

Divisions.	Number of Stations.	Average Rainfall.
Burdwan	18	0·11
Presidency	29	0·09
Rajshahye	17	0·04
Cooch Behar	6	0·01
Dacca	14	0·02
Chittagong	12	...
Patna	24	0·05
Bhagalpur	17	0·05
Orissa	13	0·50
Chutia Nagpore	9	0·19

or an average of ·1 inch over the province.

Meteorology of the Bay of Bengal on the 17th of September 1878.—The following table gives the meteorological information contained in the logs of the vessels for the 17th of September:—

	Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
1	*Loch Etive*	at Galle	...	W. S. W	Noon, 29·81	29·90	Left Galle at 5 P.M. Evening, moderate breezes; fine and clear.
2	*Fazel Kurreem*	5° 42′ N.	83° 2′ E.	S. E. in morning; S. W. afternoon.	Noon, 29·95	29·90	Morning—Sky very cloudy with thick fogs; very strong winds during the day. Afternoon—winds from south-west.
3	*First Lancashire*	9° 34′ N.	85° 40′ E.	W. S. W.	Noon, 29·70	29·85	Morning—Moderate breeze; hazy. Afternoon—Moderate breeze; overcast with heavy showers at intervals.
4	*Lagar of Ayr*	14° 12′ N.	82° 57′ E.	S. to S. W. (Force 5 to 6)	Noon, 29·50 (by Aneroid)	29·75	Fresh breeze and clear throughout the day.
5	*Racilia*	15° 22′ N.	95° 0′ E.	S. W.	...	...	Clear weather; strong breezes and high sea.
6	*Satara*	Passing from Port Blair northwards to Calcutta.		...	Noon, 29·57	29·82	Morning—Heavy squalls of wind and rain between the Andamans and Barren Island; experienced strong current setting south-east.

	Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
7	*Phuttle Barry*	18° 20′ N.	87° 18′ E.	W. to S. W. Noon, S. W.	Noon, 29 85	29·65	Morning—Strong breezes; cloudy; heavy lightning from west to north; heavy cross-sea from south-west; south horizon still gloomy. 1 P.M.—Wind unsteady. Afternoon—Heavy clouds to west-north-west; stiff breeze and drizzling rain; increasing heavy cross-sea, weather quite unsettled; horizon still gloomy.
8	*Bates Family*	18° 29 N.	86° 7′ E.	up to 9 A.M., S W. 9 A.M., N. W.	Noon, 29·75	29·65	Morning—Fresh breeze and fine clear weather; lightning to the north-west 9 A.M.—Wind at south-west hauled to the north-west with heavy squalls of wind and rain. Noon—Wind falling light with dull cloudy weather.
				Afternoon, W. N. W.	...	...	Afternoon—Light breeze and fine, wind from west-north-west.
				Midnight, W. S. W.	...	...	Midnight—Light breeze, fine and clear, wind west-south-west.
9	*Madras*	Khyouk Phyoo to Akyab.		...	Noon, 29·80	29·73	Arrived at Akyab 1-20 P.M. Morning—Calm sultry weather; light, variable airs. Afternoon—Excessively sultry evening not even the faintest air.
10	*Countess of Peebles*	20° 0′ N.	86° 48′ E.	S.W., variable.	Noon, 29·70	29·65	Moderate breeze and cloudy.
11	*Meteor, L. V.*	Intermediate station Gaspar channel ...		8 A.M., calm Noon S.S.E. 8 P.M., S.S.E.	29·79 29·70 29·78	... ...	4 A.M. Moderate breeze; fine and clear. Noon—Fine and clear. Afternoon and evening—Moderate and fine.
12	*Cassandra, P. V.*	...	...	4 A.M., S.W. Noon, S. 8 P.M., calm.	29·74 29·80 ...	29·62 ...	Morning—Force of wind 2 to 3. Afternoon and evening—Force of wind 0 to 2.
13	*Planet, L. V.*	At Eastern Channel station.		S. to S. W. during day.	Noon, 29·72	29·62	Morning—Light breeze and fine. Afternoon moderate to light breeze and fine.
14	*Mermaid, L. V.*	Mutlah station ...		4 A.M., S. Noon, S. 8 P.M., S.E.	29·72 29·75 29·72	29·62	Morning—Light breeze and slight swel. Noon—Light breeze and cloudy weather. Midnight—Light breeze and fine heavy swell.
15	*Canopus, L. V.*	Eastern Channel station		S.W. to S. by E.	Noon, 29·78	29·62	4 A.M.—Light airs and very heavy rain. Morning—Light winds and fine but cloudy. Afternoon—Light winds and fine clear weather; cloudy towards evening and moderate breezes at midnight.
16	*Chinsura, P. V.*	At the Sandheads ...		4A.M., W.N.W. 8 A.M., N.W. Noon, N.N.E. 5 P.M., E. 9 P.M., S.	29·68 29·69 29·69 29·60 29·64	29·62	Morning—Overcast. 10 A.M.—Fine. 11 P.M. and midnight—Cloudy, with lightning, wind very variable; force during day varied between 0 and 2.
17	*Comet, L. V.*	At the Upper Gaspar station.		2 A.M., S. 2 P.M., S.E. Midnight, S.S.E.	Noon, 29·69	29·62	Early morning—Light breezes and passing showers. 8 A.M.—Light breeze and fine clear weather during the whole day.
	Foam, L. V.	At the Lower Gaspar station.		4 A.M., S.W. 8 A.M., Calm Noon, Calm 4 P.M., S. 8 P.M., S.S.E. Midnight, Calm.	29·88 29·93 29·88 29·80 29·85 29·86	29·62	Early morning—Light winds and passing squalls with light showers. 8 A.M.—Light airs and calms with fine looking sky. Noon—Light airs, calms and passing showers. Midnight—Light airs and calms with cloudy sky.
18	*Janet Cowan*	6° 5′ N.	79° 14 E.	S.W. to W. during day.	30·20?	...	4-20 A.M.—A heavy squall struck the ship. 8 A.M.—Moderate gale and cloudy. Noon—Weather moderating. Midnight—Moderate breeze and cloudy.

The meteorological information, extracted from the logs of the vessels involved in the cyclone, indicate, with tolerable precision, the character of the weather over the Bay on the 17th. Over the south of the Bay, moderately strong south-west monsoon winds (force 3 to 6) were blowing. The weather, here, was just what might be expected by any one acquainted with ordinary south-west monsoon weather in the Bay of Bengal. In one portion, the sky was comparatively clear; in another it was clouded; and in a third occasional heavy showers fell. Over the south-east of the Bay, in the neighbourhood of the Nicobars and Andamans, there were very strong west-south-west monsoon winds, accompanied with moderately heavy rain. The *Satara*, leaving Port Blair on this day, experienced occasional heavy squalls of wind and rain, with a strong sea. In the centre of the Bay and off the Coromandel Coast, the winds were also from the south-west, but were not so strong as in the south of the Bay. The *Lugar of Ayr*, lat. 14°12′ N. long. 82°57′ E., had fresh breezes to strong winds with a clear sky; the S. S. *Racilia*, lat. 15°22′ N. long. 95° E., strong breezes with a clear sky. Over at least two-thirds of the Bay, steady south-west winds, of intensity varying probably from 3 to 7 (Beaufort notation), were blowing. In the north of the Bay the state of affairs was quite different. The winds were very light, with occasional calms, as shewn by the logs of several of the pilot and light-vessels, stationed in the neighbourhood of the Sandheads off the mouth of the Hooghly. They were also variable in direction during the day. In the southern portion of this area, the weather looked unsettled, as shewn by the logs of the two vessels, the *Bates Family*, and *Phuttle Barry*. The winds were unsteady, and there were occasional wind squalls with rain. Along the Arakan Coast the winds were exceedingly light, the weather sultry; and, at sunset, there was not even the slightest breath of air at Akyab (*vide log* of *S. S. Madras*). Hence the atmospheric conditions, certainly present on this day, were comparatively small differences of pressure over the north of the Bay, and in Bengal and Northern India generally, accompanied with very light winds. The winds were also in many cases unsteady and variable. Moreover, strong monsoon winds were blowing towards this area from the south of the Bay. It is evident that this strong and broad atmospheric current from the south, over the southern half of the Bay, was not accumulating, so as to produce increase of density or pressure anywhere in the north of the Bay or Northern India, for, as shown by the 10 A.M. readings of the 18th, the barometer was steadily falling at this time. Hence, the lower atmospheric current must either have been deflected very largely to the east, over Southern Burmah and the Malayan Peninsula, or else continued as a vertical upward movement over the head of the Bay. The former is indeed indicated, to some extent, by the direction of winds at Nancowry, Port Blair, Diamond Island, and Rangoon, which were all either west or west-south-west. An upward vertical movement over the head of the Bay, however, almost certainly formed a portion of the general atmospheric motion at this time; and its existence is confirmed by the occurrence of occasional squalls during the day, and by the almost immediately subsequent heavy rainfall over this part of the Bay, and the associated stormy weather.

Meteorology of the 18th of September (*Vide Plate II*).

Meteorology of India on the 18th of September.—A general diminution of pressure, slightly exceeding ·05″ in the North-Western Provinces, Assam, Arakan, Burmah, Ceylon, and along the Coromandel Coast, took place during the previous 24 hours. The Western

India barometric depression, which, on the morning of the 17th, was in the valley of the Nerbudda, had advanced westwards, and its centre, at 10 A.M. of the 18th, was in the neighbourhood of Surat. The wind velocity, at all stations in Upper India, was considerably below the average; calms or light irregular and variable winds obtained at the majority of stations in Bengal. Strong winds, on the other hand, were blowing across the west coast of India; and the wind velocity was generally above the average, at all stations in the Deccan. The wind directions, over the greater portion of Northern and Central India, indicate general indraught to the barometric depression in Western India; strongly marked on the western quadrant, and feeble in amount on the eastern quadrant; the inverse of what usually occurs in Bengal when a cyclonic vortex crosses it from the Bay. Heavy rainfall occurred over the area of barometric depression in Western India; 6·83 inches were recorded at Rajkot on this day, and 6·35 inches at Surat.

Meteorology of Bay of Bengal and the adjacent Coast area on the 18th of September.—The following table gives the more important meteorological observations recorded at stations in and near the Bay of Bengal area:—

Stations.	Barometer, 10 A.M.	Barometer reduced to sea level.	Change since previous day.	Wind direction.		Mean direction of wind for September.	Wind Velocity.			Amount of cloud, 10 A.M.	Rainfall.
				10 A.M.	4 P.M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Nancowry	29·779	29·860	—·029	W	SW	S 52° W	435·8	241·0	180·8	10	0·17
Port Blair	29·724	29·787	—·050	W	W	S 40° W	536·1	235·6	227·5	10	1·72
Diamond Island	29·656	29·698	—·091	W	WNW	S 43° W	161·7	167·0	96·8	5	0·06
Akyab	29·643	29·664	—·060	ENE	S	S 7° E	50·0	70·3	71·1	7	...
Chittagong	29·588	29·677	—·046	Calm	WSW	S 27° E	30·8	109·2	28·2	4	0·12
Dacca	29·612	29·647	—·063	Calm	Calm	S 78° E	17·0	115·0	14·8	6	0·66
Jessore	29·611	29·644	—·048	SE	ENE	S 23° E	55·5	79·0	70·3	5	...
Berhampore	29·578	29·676	—·043	ESE	SSE	S 45° E	56·1	86·4	64·9	6	...
Silchar	29·562	29·649	—·065	SSE	W	S 49° W	44·7	64·9	68·9	3	...
Goalpara	29·269	29·650	—·066	SE	Calm	S 68° E	57·0	90·8	62·8	2	...
Sibsagar	29·340	29·668	—·071	Calm	WNW	N 62° E	18·3	61·8	29·6	6	...
Purneah	29·528	29·652	—·036	SE	E	S 79° E	15·0	63·0	23·8	3	...
Durbhanga	29·478	29·643	—·053	ESE	ESE	S 87° E	80·2	91·8	87·4	6	...
Patna	29·442	29·620	—·050	E	E	S 84° E	28·6	62·5	45·8	5	...
Gya	29·239	29·613	—·040	SE	E	S 78° E	40·5	54·8	73·9	2	...
Hazaribagh	27·646	29·633	—·014	ESE	ESE	S 57° E	197·6	168·7	117·1	6	0·02
Burdwan	29·545	29·643	—·035	SE	E	S 30° E	47·5	80·9	58·7	5	...
Calcutta (Alipore)	29·615	29·636	—·040	SE by E	E by N	S 27° E	70·7	121·7	58·1	5	...
Saugor Island	29·618	29·624	—·046	WSW	SSE	S 8° W	118·9	221·2	53·7	8	...
False Point	29·617	29·632	—·016	WNW	ESE	S 32° W	94·5	167·1	56·6	6	...
Cuttack	29·554	29·634	—·016	W	W	S 7° W	30·8	61·2	50·3	4	...
Vizagapatam	29·633	29·664	—·049	NW by W	SW	N 83° E	57·5	56·3	102·1	4	...
Masulipatam	29·704	29·714	—·030	W	...	N 85° W	...	...		2	...
Madras	29·740	29·762	—·053	S by W	...	S 31° W	194·0	157·9	122·9	4	...

The preceding observations show that the barometer continued to fall with much uniformity and steadiness over this portion of the Indian area. The fall averaged ·04″ in amount, and was greatest at Diamond Island and Akyab, in the neighbourhood of the cyclonic vortex, now forming. Over the greater portion of the area, the differences of pressure were very small.

The wind observations, taken on this day, show the persistence of conditions similar to those of the 17th, in a somewhat more marked form. The winds at Port Blair and Nancowry were due west at 10 A.M., and were of much greater intensity than usual; being very nearly twice as strong as the September average. At all other stations, with the exception of Hazaribagh, Vizagapatam and Madras, the winds were considerably below their normal strength; whilst, at several stations, they were exceedingly weak. This was especially the case at Dacca (where they were only 14·8 per cent. of their average strength), at Purneah (23·8 per cent.), at Chittagong (28·2 per cent), and at Sibsagar (29·6 per cent). Calms were registered at all these stations during the day. The winds were, hence, very light, over the whole of Arakan, Bengal, Assam and Orissa. This was especially the case in South-Eastern Bengal and Assam. The wind directions at the stations in this area also indicate that, while the general direction of the lower atmospheric current was across Bengal and up the Gangetic Valley, the current was very feeble. At many of the stations, the wind directions were very variable. Thus, at Saugor Island, the wind was at west-south-west at 10 A.M. and at south-south-east at 4 P.M., while at the neighbouring station of False Point, it was at west-north-west at 10 A.M. and at east-south-east at 4 P.M. At Calcutta, the wind was from south-east by east at 10 A.M. and east by north at 4 P.M. At Akyab it shifted from east-north-east at 10 A.M. to south at 4 P.M. The most marked feature, at this time, over the land area, was therefore the prevalence of light variable winds and calms. It should, however, be carefully noted that, the direction of the lower atmospheric current in Northern India, more especially in the Gangetic plain, was quite normal, and that there is not the slightest trace of any unusual influx from the north or north-west to the area of barometric depression and cyclonic motion, which, as the observations taken from the logs of the vessels show, was now forming and developing in the north of the Bay.

The sky was overcast at Port Blair and Nancowry; at all other stations it was partially clouded and the weather fine. The amount of rain registered was exceedingly small; at Port Blair 1·72 inches were recorded, at 10 A.M., for the previous 24 hours. Light local showers fell at a few stations.

The following table gives the average rainfall for the various divisions of the province of Bengal for the 24 hours preceding 6 P. M. on this day:—

Divisions.	Number of Stations.	Average Rainfall.
Burdwan	18	0·02
Presidency	29	0·02
Rajshahye	17	0·08
Cooch-Behar	6	0·07
Dacca	14	0·07
Chittagong	12	0·59
Patna	24	0·02
Bhagalpur	17	...
Orissa	13	0·09
Chutia Nagpore	9	0·12

[1] Or an average of ·1 inch over the province.

Meteorology of the Bay of Bengal on the 18th of September.—The following table gives the whole of the meteorological information, contained in the logs of the vessels, relative to the weather in the Bay, on the 18th of September, in a compact form for comparison :—

No.	Name of Ship.	Latitude at Noon.	Longitude at Noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer	Remarks.
1	*Lock Etive*	6° 53′ N.	°51′ E.	W. S. W. to S. S. W.	29·81	29·88	Morning—Moderate winds and fine clear weather. Afternoon and midnight—Moderate winds and cloudy.
2	*Fazel Kurreem*	7° 42′ N.	85° 24′ E.	S. W.	29·86	29·85	Weather rather clearer; sun occasionally visible.
3	*First Lancashire*	11° 54′ N.	88° 13′ E.	S. W.	29·60	29·75	Morning—Moderate breeze, overcast with occasional rain. Noon—Increasing breeze with heavy rain. Afternoon—Fresh breezes with heavy rain; barometer falling rapidly.
4	*Lugar of Ayr*	16° 2′ N.	85° 7′ E.	S. W. (force 5 to 8.)	29·40	29·66	Morning—Strong gale, passing clouds; very heavy sea from south. Afternoon—Very squally sky, overcast; wind increasing at midnight; slight rain.
5	*Racilia*	17° 10′ N.	92° 26′ E.	N. W.	...	...	Afternoon—Light breezes from north-west; dull hazy weather with occasional rain. Heavy swell from west.
6	*Madras*	Left Akyab at 0·15 A. M., and arrived Kyook Phyoo, 8 A. M.		...	29·82	29·75	Morning—Much lightning with thunder and a deluge of rain at 4 A. M. Afternoon—A thunderstorm with heavy rain.
7	*Satara*	Port Blair to Calcutta		...	4 P.M., 29·36	29·61	4 P. M.—Between the Little and Great Cocos, the weather appeared very threatening.
8	*Amelie*	Left Pondicherry for Calcutta.		S. W.	29·88	...	Left Pondichery; fine south-west wind and sea very smooth.
9	*Phuttle Barry*	19° 30′ N.	89° 31′ E.	W. S. W. to W. N. W.	30·00(?)	29·64	8 A. M.—Heavy squall from west north-west, which lasted two hours with heavy clouds and lightning. Afternoon—Wind gradually moderated to a calm. At 9 P. M. a dead calm, the ship not answering her helm.
10	*Bates Family*	20° 29′ N.	87° 20′ E.	S. E. to S. W.	29·70	29·60	Morning—Light breeze, fine and clear. Afternoon—Light airs and calms. Midnight—Small rain with cloudy sky; light breeze from W. S. W.
11	*Countess of Peebles*	20° 35′ N.	87° 32′ E.	S. to W.	29·76	29·61	Light breeze and sky overcast.
12	*Meteor, L. V.*	Intermediate Station in Gaspar Channel.		4 A.M., S.S.W. Noon, calm 8 P.M., S.	29·74 29·70 29·78	...	Morning—Light breeze, cloudy, passing showers. Noon—Sultry weather. Afternoon and evening—Light airs and fine.
13	*Cassandra, P. V.*	.....		4 A.M., Calm Noon, Calm Midnight, S. S. W.	29·75 29·74	... ...	Calms and light winds. Force of wind during day varied between 0 and 2.
14	*Planet, L. V.*	At Eastern channel station		4 A.M., N. 8 A.M., W. Noon, N. W. 4 P.M., S. 8 P.M., S. E. Midnight, S. E.	29·67 29·72 29·68 29·70 29·70 29·69	... ... 29·60	Morning—Light breeze and fine. Noon—Light breeze and sultry weather. Midnight—Light airs and cloudy.

No.	Name of Ship.	Position of Vessel. Latitude at Noon.	Position of Vessel. Longitude at Noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks.
				4 A.M., S. E.	29·70	...	Morning—Light airs and fine weather.
15	*Mermaid, L. V.*	Mutlah station		Noon, E.	29·72	29·60	Noon—Light and fine heavy swell.
				8 P.M., S. E.	29·76	..	Midnight—Light airs and cloudy.
				4 A.M., W. by S.	...	...	
				8 A.M., N. N. E.	...	...	
16	*Canopus, L. V.*	At anchor, Eastern channel station.		Noon, E. N. E.	29·72	29·60	Noon—Light winds and fine.
				8. P.M., S. S. E.	4P.M. 29·63	29·51	Afternoon—Ditto ditto.
				Midnight, S.	...	...	Midnight—Light winds and cloudy, with heavy showers of rain.
				4 A.M., W. N. W.	29·73	29·64	
				8 A.M., Calm	29·74	29·65	Morning—Fine; cloudy.
17	*Chinsurah, P. V.*	.....		Noon, S. S. E.	29·69	29·60	
				9 P.M., Calm.	29·69	29·60	
				4 A.M., S. E.	...	...	
				8 A.M., E. S. E.	29·71	29·65	Morning—Light breeze and clear weather.
				Noon, E.	...	...	
18	*Comet, L. V.*	At Lower Gaspar Station		4 P.M., S. E.	...	...	Noon to Midnight—Light breeze and fine pleasant weather.
				Midnight, S. E.	...	...	
				4 A.M., S. W.	29·88	29 63	Early Morning—Light variable airs and cloudy sky.
				8 A.M., S. S. W.	29·90	29·65	
	Foam, L. V.	At Upper Gaspar Station		Noon, E.	29·85	29·60	Noon—Light airs and cloudy overcast sky.
				4 P.M., E. S. E.	29·74	29·49	
				Midnight, Calm.	...	...	Evening—Light breeze and passing clouds, with fine weather.
19	*Janet Cowan*	6° 52′ N.	83° 4′ E.	S. W. to W.	30·25?	...	Noon—Moderate breeze and cloudy. 2 P.M.—Moderate breeze and clear weather.

The extracts from the logs, given in the previous table, indicate, during the 18th, the development of the conditions, which the discussions of the logs for the 17th show were present in the Bay. Over the south and south-east of the Bay, moderately strong south-west monsoon winds continued to blow. To the east of Ceylon the weather was fine, as experienced by the *Loch Etive*; or cloudy with strong winds, as stated in the log of the *Fazel Kurreem*. In the centre of the Bay, to the north and north-west of the Andamans, or in the area immediately to the south of the area of light winds and calms, over which, there had been established, for at least 24 hours previously, a slow upward current, or ascensional movement (the continuation, in part, of the strong circulation indicated by the south-west monsoon winds over the south of the Bay), rain now began to fall in considerable amounts. Every ship within this area records rain during the day. Thus the *First Lancashire* had heavy rain; the *S. S. Racilia* hazy weather with rain; the *Madras* experienced heavy thunder-showers (with a deluge of rain at 4 A. M.); and the *Lugar of Ayr*, further to the west, had rain in the evening. To the north of this area of rainfall, *i. e.*, at the head of the Bay, the weather was fine, the winds were very light with occasional calms, and were also, as

is shewn by several of the logs, more especially those of the light-vessels and pilot brigs, very variable during the day.

As has been already shewn from the discussion of the land observations, the weather, in Bengal, was similar to that at the head of the Bay. Very light variable winds prevailed over the whole of Bengal and Behar. With one exception, *viz.*, the occurrence of concentrated local rainfall, the atmospheric conditions were almost identical with those of the previous day. The differences of pressure were again unusually small over the head of the Bay and the whole of Northern India.

The gradients were of normal strength over the south and centre of the Bay, as far north as a line from the Burmah coast across to the coast of Madras; but, to the north, there was a region of almost uniform pressure: strong moist winds were blowing towards it from the south; and, on the north, in north-eastern Bengal, exceedingly light winds, but still normal in direction, were blowing from the south towards the Gangetic plain. The barometric differences, over this area and in Bengal, were even smaller than they had been on the previous day, and the winds were also lighter.

Hence the conclusion is that, over this area, the upward motion of the moisture current, which had commenced some hours previously, had continued, and was now giving rise to general rainfall over the area of ascensional movement; and that, as is indicated by the anemometric returns of Port Blair and the facts recorded in the logs of the various vessels, the indraught to the area, from the south, was increasing; the sky was becoming surcharged with moisture and cloud; strong winds of indraught were setting in from the south; while the air motion, in the districts to the north, was diminishing in amount, and gradually changing in direction; and the weather was generally assuming a threatening appearance.

Meteorology of the 19th of September. (*Vide Plate III.*)

Meteorology of India on the 19th of September.—With a few local exceptions, *viz.*, at Sibsagar, Madras and Dera Ismail Khan, the barometer fell at all stations in India during the previous 24 hours. The fall exceeded ·05″ in amount, at the coast stations of the Bay of Bengal, from Vizagapatam to Diamond Island; and was greatest at Chittagong, where it amounted to ·076″. The distribution of pressure over Northern India was somewhat singular, the chief feature being the marked tendency towards equality of pressure over the whole of this area.

This is strikingly shewn by the pressure of the following four stations in Northern India, situated at nearly equidistant intervals—

Saugor Island	29·582
Benares	29·583
Agra	29·583
Peshawar	29·584

a difference of ·002″ only between Peshawar and Saugor Island, over a distance of 1,500 miles.

The barometric depression in Western India had not yet disappeared. The centre of the area of low pressure was, on this day, as on the 18th, in the immediate neighbourhood of Surat. The pressure over India, at this time, was considerably in defect; the deficiency

being greatest in Western India Arakan and Bengal, and least in the North-Western Provinces, the Punjab and Central and Southern India.

In Western India the winds were above average strength; more especially to the south of Surat. A gale of wind was blowing at Bombay in the morning. Over the whole of the Gangetic valley, and more especially in the Lower Provinces (Behar and Bengal), the winds, though generally normal in direction, were considerably below their average strength.

In Southern India, moderate winds, varying from south to west, prevailed during the day.

The rainfall at this time was somewhat limited, both in amount and distribution. An almost total break in the rains obtained in Bengal, Orissa, Behar and the Central Provinces. There were, however, three distinct areas of heavy rainfall in the land area.

The first was in Western India, and was almost coincident with the area of barometric depression. Rajkot appears to have been the centre of the heaviest rainfall at this time. It received 8·28 inches during the previous 24 hours; Surat recorded 4·65 inches, Neemuch 1·4 inches, Ahmedabad 1·03 inches.

The second area of general rainfall included the whole of the North-Western Provinces. The rainfall was, however, generally moderate in amount, averaging not more than ·7 inch over the province, for the preceding 24 hours. Heavy rain fell in the Shahjahanpur, Bareilly, Agra, Mainpuri, Farrukhabad, Cawnpore and Banda districts. The following table gives the average and heaviest rainfalls of the seven divisions of the North-Western Provinces :—

Names of Division.	Number of Stations.	Average rainfall of preceding 24 hours.	Heaviest rainfall at any station in preceding 24 hours.
Meerut	29	0·10	0·60
Rohilkhand	30	0·95	6·20
Agra	36	1·09	5·70
Allahabad	43	0·77	5·00
Benares	31	0·65	6·50
Jhansi	13	1·22	4·00
Kumaun	11	0·18	1·20

The third area, in which general rain was falling at this time, was along the Burmah and Arakan Coasts, in connection with the area of depression and the cyclonic vortex forming in the Bay. The amount of the rainfall was not, however, large; Diamond Island reported 1·32 inches, Rangoon 1·73 inches.

Such are the more important features of the meteorology of the Indian land area on the morning of the 19th of September. The following table gives the barometric and

wind observations taken at the observing stations round the coast of the Bay and in Arakan, Bengal, Behar, and Orissa:—

Stations.	Barometer, 10 A. M.	Barometer reduced to sea level.	Change since previous day.	Wind direction. 10 A. M.	Wind direction. 4 P. M.	Mean direction of wind for September.	Wind Velocity. Number of miles previous 24 hours.	Wind Velocity. Average for past years.	Ratio of amount of wind to average amount expressed as a per centage.	Amount of cloud, 10 A. M.	Rainfall.
Nancowry	29·747	29·826	—·032	SW	WSW	S 52° W	452·3	241·0	187·7	7	0·01
Port Blair	29·671	29·734	—·053	W	WSW	S 40° W	545·2	235·6	231·4	10	0·71
Diamond Island	29·605	29·647	—·051	SW	SW	S 43° W	171·0	167·0	102·4	9	1·32
Akyab	29·576	29·597	—·067	NE	SSE	S 7° E	44·0	70·3	62·6	6	0·14
Chittagong	29·512	29·600	—·076	N	WSW	S 27° E	29·8	109·2	27·3	6	...
Dacca	29·555	29·590	—·057	Calm.	W	S 78° E	25·0	115·0	21·7	0	0·01
Jessore	29·557	29·590	—·054	SE	E	S 23° E	23·3	79·0	29·5	4	...
Berhampore	29·524	29·622	—·054	SSE	SE	S 45° E	37·4	86·4	43·4	6	...
Silchar	29·504	29·591	—·058	E	NW	S 49° W	36·3	64·9	56·0	1	...
Goalpara	29·227	29·607	—·042	ENE	Calm.	S 68° E	80·9	90·8	89·0	1	...
Sibsagar	29·344	29·679	+·004	NNE	ENE	N 62° E	76·8	61·8	124·3	10	2·06
Purneah	29·462	29·586	—·066	SE	NE	S 79° E	45·0	63·0	71·4	5	...
Durbhanga	29·419	29·583	—·059	ESE	ESE	S 87° E	37·1	91·8	40·4	7	...
Patna	29·395	29·571	—·017	E	E	S 84° E	31·9	62·5	51·0	4	...
Gya	29·200	29·573	—·039	Calm	Calm.	S 78° E	24·5	54·8	44·7	4	...
Hazaribagh	27·602	29·579	—·044	SW	SSW	S 57° E	133·1	168·7	78·9	5	0·55
Burdwan	29·501	29·599	—·044	E	E	S 30° E	27·5	80·9	34·0	5	...
Calcutta (Alipore)	29·575	29·596	—·040	WSW	W by S.	S 27° E	63·0	121·7	51·8	8	0·39
Saugor Island	29·583	29·589	—·035	N	SSW	S 8° W	131·0	221·2	59·2	6	...
False Point	29·567	29·582	—·050	N	ESE	S 32° W	104·0	167·1	62·0	9	0·70
Cuttack	29·524	29·605	—·030	WNW	Calm.	S 7° W	22·3	61·2	36·4	4	...
Vizagapatam	29·566	29·597	—·067	WNW	SE	N 83° E	42·7	56·3	76·0	1	...
Masulipatam	29·656	29·666	—·048	W	...	N 85° W	...	...	...	2	...
Madras	29·732	29·754	—·008	WSW	...	S 31° W	228·	157·9	144·4	3	...

Meteorology of Bengal and the coast districts of the Bay of Bengal for the 19th of September.—The barometer, as shewn by the preceding observations, fell with considerable uniformity over the whole area, including the stations given in the table. The fall averaged ·05″ in this area, and was greatest along the east coast of the Bay, at Chittagong and Akyab. It was however, as already noted, partly, if not mainly, a general oscillatory change in the atmosphere; little, if at all, connected with the local changes of pressure accompanying the development of the small cyclonic vortex in the Bay. The table also illustrates, clearly, the very small differences of pressure obtaining over a large portion of this area, including Arakan, Assam, Bengal, Behar, Chutia Nagpore and Orissa.

The character of the air movement is also very fully indicated by the table. The wind velocity was below the September average at all stations, excepting Nancowry, Port Blair, Diamond Island, Madras and Sibsagár; it was greatest at Port Blair, where

545·2 miles were registered; the average for September at that station being only 235·6 miles. Hence the anemometric observations, at the more southerly stations of the Bay area, continue to confirm the general statements in the logs of the vessels, that over the south and centre of the Bay, moderate to strong monsoon winds were blowing.

In the land area to the north-west, north, and north-east of the Bay, the air movement was much below the average. The area of least relative air motion or of greatest stagnation was in Eastern and Central Bengal, as represented by the stations of Chittagong (where the air motion was 27·3 per cent. of its normal amount), Dacca (where it was 21·7 per cent.), and Jessore (where it was 29 per cent.).

The wind directions show that, at the majority of the stations in South-Western Bengal, the lower atmospheric current (although feeble) was from the south, and that in Behar and North-Western Bengal it continued as a current from the east. In other words, the lower atmospheric circulation, although very considerably below its normal strength, was, at this time, fairly normal in character and direction (although the cyclonic vortex that had already formed was moving northwards). The area in South-Eastern Bengal, where the winds were unusually light, was the only region in which the winds were distinctly variable, irregular, and abnormal. Thus, at Akyab, the wind, at 10 A. M., was from north-east, and at 4 P. M., was from south-south-east. The wind directions, for the same hours, at Chittagong, were north and west-south-west; at Dacca they were calm and west; and at the neighbouring station of Jessore they were south-east and east. Hence, this area, like the area at the head of the Bay, as shewn by the logs of the light and pilot vessels, was one in which "light variable airs and calms" prevailed.

The sky was partially clouded at all stations, excepting Port Blair and Silchar, where it was overcast. The weather was therefore generally fine, with light winds and passing clouds.

The rainfall of the preceding twenty-four hours, at the land stations, was exceedingly small in amount. The Port Blair and Diamond Island returns show that moderate rain was falling there. The character and amount of the rainfall in the province of Bengal is most clearly shewn by the following table:—

Divisions.	Number of Stations.	Average rainfall.
Burdwan	18	0·04
Presidency	29	0·04
Rajshahye	17	0·05
Cooch Behar	6	0·08
Dacca	14	...
Chittagong	12	...
Patna	24	..
Bhagalpur	17	0·16
Orissa	13	0·09
Chutia Nagpore	9	0·15

giving an average of only ·06 inch for the province.

Meteorology of the Bay of Bengal on the 19th of September.—The following table gives, in a condensed form, the whole of the meteorological information contained in the logs of the vessels for the 19th September. The brief descriptions of the weather are quoted *verbatim*, and in their entirety, from the logs:—

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Force.	Barometer, actual reading.	Barometer, probable corrected reading.	Remarks on Weather.
Loch Etive	9° 11′ N.	84° 29′ E.	S. W. to S. S. W.	...	29·78	29·85	Morning—Moderate breezes and fine cloudy weather. Noon—Steady breezes and cloudy. Evening—Moderate breezes and cloudy.
Fazel Kurreem	10° 27′ N.	86° 51′ E.	S. W.	...	29·80	29·75	Strong winds from the south-west generally cloudy; weather unchanged
Madras	Khyouk Phyoo to Akyab.		...	...	29·60	29·53	Morning—Nice land breeze from south-east. Long swell from south-south-west. 3 P.M.—Arrived at Akyab. Heavy showers and much lightning.
Sattara	Port Blair to Calcutta. Probable position 17° N or 18° N.		...	...	4A. M., 29·28	29·53	Morning—Thick heavy rain with moderate gale and high sea. Wind veering from south-west to west-north-west. Noon—Fresh gale with high sea. Midnight—Fresh gale with heavy squalls of wind and rain. Wind veering to the north-west in the squalls.
Lugar of Ayr	17° 48′ N.	87° 56′ E.	Morning, S.-W. Noon, variable. Afternnon, N. W. to N.-E.	7 to 8. 1	29·35	29·60	Morning—Strong gale; gloomy weather with showers; thunder and lightning to north. 10 A.M.—Hard squalls from north-west and very heavy sea from south-east. Noon—Heavy rain; sea calm. Afternoon and midnight—Winds very light and very variable; much thunder and lightning; constant heavy rain.
First Lancashire	15° 20′ N.	89° 40′ E.	W. to N.-W.	...	Noon, 29·40 8 P.M., 29·35	29·55 29·50	Morning—Fresh and squally. Noon—Heavy rain. The sky now assumed every appearance of a storm. Dense heavy clouds of greenish color hung all round the horizon. Wind veered to north-west and blew very hard till 10 P.M., attended with a deluge of rain, when clouds began to break up to the east, a dense bank of clouds still remaining to the west.
Raclia	19° 18′ N.	87° 75′ E.	N.-W.	...		...	Fine clear weather, with light breeze from north-west.
Phuttle Barry	19° 45′ N.	87° 29′ E.	Morning, W. N. W. Afternoon, calm.	...	30·00(?)	29·55 (?)	Morning—Light winds and calms. Horizon dark and cloudy, more particularly to the west. Afternoon—Light winds and calms and unsettled cloudy weather.
Bates Family	20° 36′ N.	88° E.	Morning, W. to W. N.-W. Noon, N. N. E. Evening, N.E. Midnight, S. W.	...	29·66	29·56	Early morning—Light breeze; fine and clear weather. 5 A.M.—Light airs with heavy rain. Noon—Light winds; fine and clear. Evening—Light airs with very fine weather; calm and smooth sea.
Amelie	Position not given.		S. W.	...	...	...	The wind freshened a little and the sea rose slightly.
Meteor, L. V.	Intermediate station in Gaspar Channel.		S. S. E.	...	Noon, 29·60(?)	...	Light, steady south-south-east breeze, and fine weather during the day.
Cassendra, P. V	Cruising at the Sandheads		4 A.M., S.S.W. 8 A.M. to midnight, calm	... ...	4 A.M., 29·68 Noon, 29·64	29·58 29·64	Force of wind varied between 0 and 1. Light airs and fine weather.

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Barometer probable corrected reading.	Remarks on weather.
Planet, L. V.	Relieved by *Canopus* and proceeding to Calcutta.		Morning ... S. E. to E.	29·67	29·57	Morning—Light airs and cloudy.
			Noon, S. E. ..	29·68	29·58	Noon—Light airs and fine.
			4 P. M., N. ...	29·70		
			8 P. M., N. E. ...	29·69		
			Midnight, ... N.E.	29·69		
Mermaid, L. V.	At Mutlah station		1 A. M., S. E. ...	...	...	Morning—Calm and cloudy; fine weather.
			4 A. M., calm ...	29·74	29·62	
			Noon, E. ...	29·65	29·53	Noon—Light airs and fine weather.
			4 P. M., S. W. ...	29·58	29·46	Evening—Calm and clear; lightning to the north-west.
			8 P. M. to midnight, calm ...	29·68	29·56	Midnight—Calm and cloudy weather.
Chinsurah, P. V.	Cruising at the Sandheads.		1 A. M., W. S. W. 1	29·63	29·54	Morning—Cloudy and overcast.
			3 A. M., W. N. W. 1	29·63	29·54	
			6 A. M., N. N. W. 1	29·64	29·55	
			2 P. M., calm ...	29·67	29·58	6 P. M.—Threatening appearance to the north, overcast with rain.
			7 P. M., N. 1	29·64	29·55	
			9 P. M., N. N. E. 1	29·63	29·54	
Canopus, L. V.	Eastern channel station.		4 A. M., N. by E. ...	29·70	29·56	Morning—Light breeze and fine weather.
			8 A. M., N. by E. ...	29·71	29·57	
			Noon, N. E. by N. ...	29·71	29·57	Noon—Light breeze and fine weather.
			4 P. M., E. by N. ...	29·65	29·51	
			8 P. M., S. S. W. ...	29·70	29·56	
			Midnight, N. W. ...	29·70	29·56	Midnight—Light airs and fine weather.
Comet L. V.	At Lower Gaspar station.		4 A. M., E. ...	...	...	Morning—Light variable airs and calm.
			8 A. M., E. S. E. ...	29·67	29·59	
			Noon, E. S. E ...	29·64	29·56	Noon—Light breeze and hot sultry weather.
			8 P. M., S. S. E. ...	...	...	
			Midnight, S. S. E. ...	29·72	...	6 P. M. to midnight—Light variable airs.
Foam L. V.	At Upper Gaspar station.		4 A. M., S. E. ...	29·80	29·55	Early morning—Light airs and fine. clear weather.
			8 A. M., N. ...	...	...	
			Noon, E. ...	29·78	29·53	Noon—Light winds and fine with light fine weather clouds.
			4 P. M., S E. ...	29·75	29·50	
			8 P. M., W. S. W. ...	29·82	29·57	Evening—Light airs and cloudy overcast sky.
			Midnight, W. S. W. ...	29·80	29·55	Midnight—Light airs and calms with light cloudy sky.
Janet Cowan	9° 10′ N.	85° 5′ E.	S. W. by S.	30·30?	...	Noon—Moderate breeze and sky clear. Midnight—Gentle breeze and clear weather.

The chart of the 19th indicates the continuance of the same feature as heretofore, *viz.*, uniform pressure over the most northern portion of the Bay and the adjacent districts of Northern India. It is even more strikingly exhibited on this than on the previous days. The extracts from the logs of the vessels also indicate the continuance of similar conditions in the Bay, and the development of the natural sequences of these conditions.

In the south of the Bay strong south-west monsoon winds continued. This is indicated, not merely by the logs of the *Loch Etive*, *Fazel Kurreem* and *First Lancashire*, but also by the observations taken at Nancowry and Port Blair.

In the north of the Bay there was, on the other hand, a totally different set of conditions. The logs of the various light and pilot vessels, and also of the vessels near the mouth of the Hooghly at the time (including the *Bates Family* and *Countess of Peebles*), show that the winds were extremely light, varying in force from 0 to 2, and that they were, moreover, very variable and irregular. Between the area of strong steady south-west humid winds in the south of the Bay, and the area of light, variable and irregular winds in the north of the Bay, there was an area occupying almost the same extent and position in the Bay as on the 18th, and in which concentrated heavy rainfall occurred during the day. In other words, the area of moderate rainfall of the 18th became, on the 19th, an area of heavy rainfall, with its invariable accompaniments—severe squalls, strong winds, heavy seas, and increasing stormy weather.

For example, the *First Lancashire*, in latitude 15° 20′ N., had very heavy rain at noon and a deluge of rain in the evening. The *Lugar of Ayr*, further north, latitude 17° 48′ N. at noon, had showers in the morning, heavy rain at noon, and constant heavy rain in the afternoon and up to midnight. The *Satara*, proceeding from Port Blair to Calcutta, and probably in about latitude 17° N. to 18°N. at noon, had thick heavy rain during the morning, and fresh squalls with heavy rain in the evening. Hence, as on the 18th, the area included by the parallels of latitudes 12°N. and 18°N. and meridians of longitude 85° and 93° E., was, during the whole of the day, one of very heavy rainfall, more or less continuous in character. It is, therefore, almost certain that, the south-west monsoon current, strong to the south of latitude 12°, and barely traceable and exhibited only in the lightest southerly airs to the north of latitude 18°, was, over this area, mainly continued as an ascending current. The heavy continuous concentrated rainfall, which was occurring, was, on the one hand, the natural sequence of this vertical ascending current; and, on the other hand, it promoted and increased the circulation, which initiated the rainfall, by the rapid conversion of the potential energy of aqueous vapour into the kinetic energy of the atmospheric movement.

Meteorology of the 20th of September (Vide Plate IV).

Meteorology of India on the 20th of September.—During the preceding 24 hours, pressure had increased considerably at all the reporting stations, excepting Jubbulpore and Sibsagar.

It appears to be desirable to state, more fully than I have hitherto done, that extensive general oscillations of the barometer, common to the whole of the Indian area, may be, and often are, of no more significance in connection with the changes of the weather, than the diurnal oscillation of the barometer. A recent analysis of the daily telegraphic

weather reports for the whole of India, indicates clearly, what might be assumed from our present acquaintance with the remarkable uniformity of the changes of pressure over the Indian area, *viz.*, that the large annual oscillation or periodic fluctuation of the barometer is not a simple oscillation, but that there are combined with it, numerous, minor oscillations, several of which, however, compound into a fairly uniform oscillation, varying slightly with the season, from four to five days in length. This oscillation is, therefore, one feature of the uniform atmospheric changes, and hence, like the annual or diurnal oscillation, its effect must be eliminated, if we wish to determine the actual variations from the ordinary atmospheric condition or state, as measured by the barometer, at any time; constituting weather, as distinguished from climate, or regularity as distinguished from irregularity. Hence a general rise of the barometer, occurring at the period of increase of pressure of this minor oscillation, may be of no significance whatever; but if occurring at the opposite phase, it may be due to some brief but extensive change, produced by external causes, operating on the atmosphere over the Indian area. The study of these oscillations, intermediate in period between the diurnal and annual oscillations, has only as yet been commenced. A preliminary investigation, however, appears to indicate that, the period is somewhat longer in the rainy than in the dry weather; probably averaging four days in the former, and five days in the latter. The amplitude of the oscillation appears to be nearly one-tenth of an inch. This is, however, as might be expected, different at different periods of the year, varying slightly with the atmospheric conditions at the two opposed seasons of the year, the dry season and rainy season. The oscillations also occur at slightly different periods, in different parts of India, so that the initial rise of the barometer, in one region, occurs with or overlaps the terminal fall of the barometer in another region of the Indian area. But, generally, during the greater part of each period (and so far as this action alone is concerned), the barometer is either rising or falling simultaneously over the whole of India.

The only fact of importance, in connection with the present investigation, that it is necessary to bear in mind is, that a general fall or rise of the barometer, over the whole of India may be of little or no significance whatever, in connection with local atmospheric action, such as the formation of a cyclonic vortex in a small area and corner of the Bay.

It will be seen that the general rise of the barometer, on the 19th, followed a period of falling barometer, lasting from the 15th to the 18th, and that it extended over the whole of India (with local exceptions due to local actions). Over India, therefore, there was some general oscillatory motion or change of the atmosphere, one effect of which was to produce a general increase of pressure. The total amount of the increase, during the previous 24 hours, was greatest in Western India; where the general rise was supplemented and increased by the local rise, accompanying the disappearance of the cyclonic vortex referred to at page 16. The rise was greatest at Surat, where it slightly exceeded ·1″, and it averaged ·05″ over the Punjab, Sind, Gujrat, Bombay, Central India and Rajputana.

A local area of slightly diminished pressure stretched across the head of the peninsula, from Surat to Allahabad and Patna. The lowest pressure, recorded at 10 A.M., was observed at Khandwa, in the centre of this area. With the exception of this area of slight barometric depression, pressure was very uniform over the whole of Northern

India. The following will illustrate this marked tendency to almost absolute uniformity of pressure at this period :—

Silchár	29·611	Bareilly	29·621
Calcutta	29·609	Mooltan	29·612
Hazaribagh	29·611	Surat	29·609
Akola	29·613		

The winds, along the west coast, were more moderate in character than they had been for some days previously. Feeble cyclonic motion, however, continued for some hours after the disappearance of the vortex or barometric depression in Gujrat. Over the whole of Northern India the air motion was below the average. This was especially the case in Bengal. The average wind velocity for the reporting stations in Behar the North-Western Provinces and the Punjab, for the day, was only 57·8 miles per day, whilst the normal average is 67·8 miles per diem. The rainfall of the preceding 24 hours was considerably less than that of the previous day. It occurred, however, almost entirely in the same three areas, as on the 18th and 19th. In the Western Indian area of barometric depression, 3·1 inches fell at Surat and 6·5 inches at Bombay.

The rainfall over the North-Western Provinces was again considerable, but was much less than in the previous day, except in Oudh and the Basti district of the North-Western Provinces.

The rainfall, along the east coast of the Bay and Burmah, was also smaller than on the previous day. Akyab registered 0·48 inch and Rangoon 0·64 inch. The general features of the meteorology of Northern India, at this time, were, therefore, extremely simple. The approximation towards uniformity of conditions, accompanying a general stagnation of the atmosphere, was most distinctly and even strongly marked.

Meteorology of Bengal and the coast districts of the Bay of Bengal on the 20th of September.—The following observations for the 20th of September show the same features, more in detail, for the coast stations round the Bay and in Bengal and Behar :—

Stations.	Barometer, 10 A.M.	Barometer reduced to sea level.	Change since previous day.	Wind Direction. 10 A.M.	Wind Direction. 4 P.M.	Mean direction of wind for September.	Wind Velocity. Number of miles previous 24 hours.	Wind Velocity. Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.	Amount of cloud, 10 A.M.	Rainfall.
Nancowry . . .	29·79	29·859	+·032	SW	SW	S 52° W	402·4	241·0	167·0	9	0·26
Port Blair . . .	29·20	29·783	+·049	SSW	SW	S 40° W	456·7	235·6	193·8	10	0·50
Diamond Island . .	29·635	29·677	+·030	SW	SSW	S 43° W	285·0	167·0	170·7	8	0·16
Akyab	29·603	29·624	+·027	SE	S	S 7° E	54·0	70·3	76·8	4	0·48
Chittagong . . .	29·545	29·634	+·033	NNW	SW	S 27° E	38·7	109·2	35·4	10	...
Dacca	29·569	29·605	+·014	Calm	Calm	S 78° E	24·0	115·0	20·9	10	0·12
Jessore	29·578	29·608	+·018	ESE	E	S 23° E	18·4	79·0	23·3	5	...
Berhampore . . .	29·544	29·642	+·020	ESE	NNW	S 45° E	36·1	86·4	42·0	7	0·07
Silchar	29·525	29·612	+·021	E	ENE	S 49° W	58·6	64·9	90·3	7	...
Goalpara . . .	29·268	29·648	+·041	ESE	SSE	S 68° E	115·9	90·8	127·6	0	...
Sibsagar . . .	29·318	29·646	—·026	ENE	ENE	N 62° E	46·9	61·8	76·0	4	...
Purneah . . .	29·496	29·620	+·034	ENE	ENE	S 79° E	28·0	63·0	44·4	5	...

Stations.	Barometer, 10 A.M.	Barometer reduced to sea level.	Change since previous day.	Wind Direction		Mean direction of wind for September.	Wind Velocity.		Ratio of amount of wind to average amount expressed as a percentage	Amount of cloud, 10 A.M.	Rainfall.
				10 A.M.	4 P.M.		Number of miles previous 24 hours.	Average for past years.			
Durbhanga	29·456	29·620	+·037	ESE	ENE	S 87° E.	42·9	91·8	46·8	3	...
Patna	29·418	29·595	+·023	E	ENE	S 84 E	22·5	62·5	36·0	6	...
Gya	29·227	29·599	+·027	Calm	Calm	S 78° E	20·0	54·8	36·5	2	...
Hazaribagh	27·637	29·611	+·035	NNW	W	S 57° E	91·5	168·7	54·2	7	0·01
Burdwan	29·514	29·612	+·013	E	Calm	S 30° E	36·0	80·9	44·5	5	0·57
Calcutta (Alipore)	29·590	29·611	+·015	NW	E	S 27° E	73·0	121·7	60·0	7	...
Saugor Island	29·604	29·610	+·021	NNW	NNW	S 8 W	105·3	221·2	47·6	9	0·60
False Point	29·601	29·616	+·034	Calm	Calm	S 32° W	85·6	167·1	51·3	7	...
Cuttack	29·547	29·627	+·023	WNW	Calm	S 7 W	33·7	61·2	55·0	4	0·17
Vizagapatam	29·609	29·640	+·043	W	W by N	N 83° E	30·0	56·3	53·2	9	...
Masulipatam	29·679	29·689	+·023	W	...	N 85° W	...	...	...	3	...
Madras	29·755	29·777	+·023	SW by W	...	S 31° W	238·0	157·9	150·7	4	...

The barometer, which had been falling during the previous three days, now began to rise again. The increase of pressure, during the preceding 24 hours, was small in amount, but generally uniform at the observing stations, and averaged ·02″. The relative distribution was hence unchanged; and over Arakan, South Assam, Bengal, Behar and Orissa, the differences of pressure were, as they had been on the 20th, unusually small, and due, probably, to mere local variations.

The characteristic features of the air motion were almost identical with what they had been for the previous day, the 19th. The velocity of the wind at Nancowry, Port Blair, Diamond Island and Madras was considerably above the average, and indicated that the monsoon winds, over the south and centre of the Bay, were probably, at least, fifty per cent. above their normal strength.

The wind velocity at all the other stations given in the table (excepting Goalpara) was below the average. This diminished air motion was most strikingly exhibited at the stations in South-eastern Bengal. At Dacca the amount registered at 10 A. M. was only 23·3 per cent. of the September average amount, and at Jessore 20·9 per cent. At the neighbouring stations of Saugor Island, False Point, Calcutta and Burdwan, the air velocity averaged upwards of fifty per cent. of its normal amount for September. Hence the observations, for this day, show most clearly that the stagnation of the air was excessive over a small area in South-eastern Bengal, and that it was a well-defined and strongly marked meteorological feature at this period. It was, in fact, as persistent a feature over the small area, as the general equality of pressure was of the much larger area including Arakan, Bengal, Behar and Orissa.

In the south and centre of the Bay (as shown by the returns from Port Blair, Nancowry, Diamond Island, &c.) the ordinary south-west monsoon winds prevailed. At the head of the Bay the wind directions, at Saugor Island and Calcutta, during the day, and at Chittagong at 4 P. M., seem to indicate that the influence of the cyclonic vortex

was now slowly extending to Southern Bengal. The winds shifted round to the north, but were, as has already been stated, of very feeble intensity; calms were registered at an unusually large number of stations in Bengal and Orissa. Further to the north and west, the easterly winds, which prevailed in Behar and Northern Bengal, indicate that the lower atmospheric motion in this part of India continued to be normal in direction, and was maintained independently of the local cyclonic motion further south in the Bay. The velocity of the wind, as might naturally be anticipated, was however slowly diminishing with the northward advance of the cyclonic vortex. As on the 19th, the sky was overcast at Port Blair. It also now became overcast in the area of least air motion (*viz.*, at Dacca and Jessore), and was clouding over at the other stations near the head of the Bay and in Bengal.

The rainfall registered during the day was slight, and chiefly due to local showers. Light rain fell in the Burdwan, Dacca, Chittagong and Orissa divisions of the province of Bengal. The following table gives the average amount of the fall in the various divisions:—

Divisions.	Number of Stations.	Average Rainfall.
Burdwan	18	0·35
Presidency	29	0·04
Rajshahye	17	0·08
Cooch Behar	6	0·02
Dacca	14	0·24
Chittagong	12	0·46
Patna	24	0·11
Bhagalpur	17	0·01
Orissa	13	0·28
Chutia Nagpore	9	0·05

giving an average of ·16 inch nearly for the province.

The Meteorology of the Bay of Bengal on the 20th of September.—The following table gives, in a brief form, the weather remarks and meteorological observations contained in the logs referring to the 20th of September:—

No.	Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks.
1	*Loch Etive*	11° 38′ N.	85° 43′ E.	S.W. to W.S.W.	29·78	29 85	Morning—Moderate breezes and fine. 6 P.M.—Fresh breezes with heavy clouds to the north. Midnight—Fresh breezes with fine cloudy weather.
2	*Fazel Kurreem*	13° 12′ N.	88° 12′ E.	W.	29·72	29·67	Morning—Strong winds from the west. 6 P.M. to midnight—Very heavy rain, cloudy thick weather; strong winds in evening; vessel rolling much.

No	Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks.
3	*Madras*	Akyab to Calcutta ...		...	29·68	29·63	Morning—Fine land breeze; increasing sea from S.S.W. Afternoon—Calms with sultry steamy weather. Evening—Very heavy rain with very heavy thunder and lightning from the south.
4	*First Lancashire*	17° 20′ N.	90° 40′ E.	W. to W.N.W.	Noon, 29·80 8 P.M. 29·40	29·45 29·55	Fresh gale attended with violent squalls and heavy rain during the day; heavy westerly swell rose at the end of the day.
5	*Phuttle Barry*	20° 7′ N.	88° 9′ E.	Morning, calm Afternoon, W. to N.W.	29·72	29·52	Morning—Light winds and calms and cloudy weather. Afternoon—Heavy sea; threatening and cloudy; weather quite unsettled, with drizzling rain and much lightning; appearance of weather bad; horizon very black.
6	*Satara*	Port Blair to Calcutta ...		...	29·24	29·49	Morning—Moderate winds; cloudy with heavy rain at times. Noon—Squalls with heavy rain and high confused sea; strong current to the westward. Midnight—Heavy and violent squalls, with sudden shift of wind to N.W.; lightning to the east and torrents of rain.
7	*Luyar of Ayr*	20° 11′ N.	88° 44′ E.	Morning variable, force 6 to 1. Afternoon, N.W. to E.	29·30 ...	29·55 ...	Morning—Squally with very heavy rain; wind very variable and unsteady; a deluge of rain up to noon and wind all round the compass many times. Afternoon—Weather the same until midnight, when the rain ceased with a calm; a few stars were then visible.
9	*Bates Family*	20° 49′ N.		Morning, S.W. Afternoon, N.E.	29·66 ...	29·56 ...	Morning—Light airs with very fine weather. Afternoon—Fine clear weather; 2·30 P.M. sighted light-ship.
10	*Moulmein*	Going down River Hoogly.		...	6 P.M., 29·50	...	5·30 P.M.—Heavy rain and squalls from north-east with high cross sea.
11	*Amelie*	...	...	S. W. ...	...	...	The wind continued to increase slowly in intensity and the sea to rise.
12	*Racilia*	21° 31′ N.	86° 24′ E.	S. E. ...	...	...	Light breezes; weather dull with vivid flashes of lightning.
13	*Meteor, L. V.*	Intermediate station in Gaspar channel.		4 A.M., N.W 8 A.M., N.W. Noon, calm. 4 P.M., calm. 8 P.M., N. ... Midnight, N.	29·78 29·84 29·80 29·70 29·76 29·76	29·58 29·64 29·60 29·50 29·56 29·56	Morning—Light airs and fine. Noon—Clear weather. Afternoon and evening—Light airs and dark cloudy weather. Ditto.
14	*Cassandra, P. V.*	...	...	Calm with occasional airs from N. or N.N.W	Noon, 29·70. 8 P.M., 29·70	29·60 29·60	Force of wind varied between 0 and 2.
15	*Planet, L. V.*	Passing from Eastern Channel station to Calcutta.		Morning, N.E. Noon, N.E. Midnight NE.	Not observations given in log.	...	8 A.M.—Light breeze from north-east. Noon—Light winds and cloudy weather. 2·30 P.M.—Fresh breeze; heavy squalls from north-east. Midnight.—Moderate breeze, with threatening-looking weather.

No	Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks.
16	*Mermaid, L. V.*	Mutlah station,		4 A.M., Calm.	29·65	29·53	Morning—Light airs and cloudy weather.
				8 A.M., N.N.E	29·68	29·56	
				Noon, N. E.	29·68	29·56	Noon—Light airs and fine weather; sky overcast.
				4 P.M., E.N.E.	29·60	29·48	
				8 P.M., E.	29·68	29·56	Evening—Light airs; sky overcast.
				Midnight, N.	29·68	29·56	Midnight—Light airs; sky cloudy.
17	*Chinsurah, P. V.*	(Buoy Station)		5 A.M., NNE.	29·65	29·56	Weather fine during the whole day.
				9 A.M., ENE.	29·65	29·56	Evening—Lightning to northward.
				5 P.M., E.S.E.	29·59	29·50	
				7 P.M., S.	29·61	29·52	
18	*Canopus, L. V.*	Eastern Channel Station		4 A.M., NNW	29·70	29·56	Morning—Light breeze and cloudy weather.
				8 A.M., N. W. by W.	29·72	29·58	
				Noon, N.N.W.	29·72	29·58	Noon—Light airs and cloudy weather.
				4 P.M., Calm.	29·68	29·54	
				8 P.M., N. E. by N.	29·70	29·56	8 P.M.—Light airs and cloudy weather, with thunder and lightning.
				Midnight E. N. E.	29·69	29·55	Midnight—Light winds and cloudy weather.
19	*Camona*	0° 49′ S.	85° 35′ E	4 A.M., S., Force 3.	29·76		
				Noon, W S W., Force 9.	29·83		
				4 P.M., W. S. W. Force 4	29·76	...	Noon—A squall came up suddenly from west-south-west; wind in heavy gusts with very heavy rain.
				Midnight, W. S. W. Force (3).	29·86		
20	*Comet, L. V.*	At Lower Gaspar station.		4 A.M., S.S E			4 A.M.—Light airs and calms.
				8 A.M., calm.			
				Noon, calm.	29·67	29·59	8 A.M. Noon. } Calm and hot sultry weather.
				4 P.M., N. N. E.	29·69	29·61	2 P.M.—Light variable airs.
				8 P.M., N W.	29·70	29·62	5 P.M.—Heavy squall from north-east with heavy rain.
				Midnight, N. W.	..	...	Midnight—Light breeze and cloudy.
21	*Foam, L. V.*	At Upper Gaspar station.		4 A.M., W. S. W.	29·78	29·54	4 A.M.—Light airs and fine, with a few light clouds.
				8 A.M., W. N. W.	29·75	29·51	8 A.M.—Similar weather.
				Noon, S.W.			Noon—Very hot and sultry; heavy swell settled in from seaward.
				4 P.M., N. W.	29·78	29·54	3 P.M.—Light airs and calms and a squally rain-looking sky.
							4 P.M.—Squall from the north-east.
				8 P.M., W. N. W.	29·80	29·56	6 P.M. to 11 P.M.—Light winds and squally rainy-looking sky; thunder and lightning in great quantities.
				Midnight, N. N. W.			Midnight—Light winds and fine looking sky; thunder and lightning leaving off.
22	*Janet Cowan*	12° 19′ N.	87° 13′ E.	S. W. by S. during day.	30·25 ?	...	8 A.M.—Fresh breeze and cloudy.
							Noon—Fresh breeze and cloudy. Found a stron gcurrent setting to the N.-E.
							8 P.M.—Heavy cloudy weather with a threatening appearance.
							Midnight—Fresh breeze and cloudy.

The chart of the 20th, as has already been stated, shows the persistence of uniform pressure over nearly the whole of India and the Bay of Bengal to the north of latitude 20°. The differences of pressure over the whole extent of this area, excluding a small local area of depression in Behar, were less than ·05″. In the Bay, as is shown by the logs of the vessels, the continuous rainfall of the past two days was now associated with an area of barometric depression to the north-west of the Andamans. The centre was probably nearly midway between the Andamans and Saugor Island. The only evidence of its existence, *viz.*, the logs collected by the Port Officer, also indicate that the barometric depression was of comparatively small amount, probably not more than a quarter of an inch; the barometer, in the central area at 10 A.M., standing at 29·10 instead of 29·65 (the normal height at 10 A.M., in September, at the head of the Bay).

The general atmospheric conditions over the Bay were almost identical with what they were on the 18th and 19th. In the south of the Bay, as experienced by the *Loch Etive* and *Fazel Kurreem*, strong south-west monsoon winds continued with great steadiness. The *Loch Etive*, in latitude 11° 38′ N. at noon, had fine weather and moderate winds during the day, but observed heavy clouds to the north in the evening. The *Fazel Kurreem*, further north, in latitude 13° 12′ N. at noon, experienced strong winds during the day, and had heavy showers of rain in the evening. At the head of the Bay, light variable and irregular winds continued until the afternoon or evening of the 20th. The *Racilia*, *Bates Family* and all the light vessels and pilot vessels described the weather and winds in similar language "light breezes," "light airs with very fine weather," "light airs and cloudy weather," &c. The variability in the direction of the winds is also very strikingly exhibited by the wind observations of the various light and pilot vessels, given in the preceding table. Between these two portions of the Bay, there was, as on the 19th, an area of heavy rain, which now extended northward to latitude 20° N. The *Phuttle Barry*, in latitude 20° 17′, had threatening cloudy weather, with drizzling rain during the afternoon. She was evidently on the northern verge of the storm and rain area. The *Lugar of Ayr*, which was in lat. 20° 11′ N. by account, had very heavy rain in the morning, with variable winds and a deluge of rain during the day and until midnight. The captain especially remarks that the winds went all round the compass many times. This single observation seems to be especially significant, as showing the unsteady, intermittent and irregular action on the northern side or quadrant of the area of rainfall; as different from the steady moderate gale on the southern quadrant, as can well be conceived. The *Satara* had heavy rain, at intervals, during the morning, and heavy rain with squalls in the afternoon, and torrents of rain in the evening.

The *Madras*, which left Akyab for Calcutta at 3 P.M., experienced very heavy rain during the evening, due to a thunder-storm advancing from the south across the path of the vessel to the north.

The general character of the weather and of the changes taking place, are as clear and intelligible as they were for the 20th. The horizontal south-west monsoon current, over the south and centre of the Bay, was converted into a vertical current over the area of barometric depression in the north of the Bay. This continued to determine very heavy precipitation of rain over this area. The northern edge of the area of rainfall evidently extended northward during the day. Probably, the whole area of rainfall was

now travelling northward, so that the centres of rainfall and of barometric depression were both advancing in a northerly direction.

Meteorology of the 21st of September (*Plate V*).

Meteorology of India on the 21st of September 1881.—The barometer, at 10 A.M., showed a further increase of pressure over the whole of India, with the local exceptions of Saugor Island and Peshawar. The increase was greatest in Guzerat and at Khandwa, and slightly exceeded ·1 inch at Surat, Rajkot and Deesa. It varied from ·05 inch to ·1 inch in Sind, Guzerat, Bombay, the Berars, the Malabar Coast and in Ceylon. The barometer was rising somewhat more slowly in Northern India and Madras. It was, however, rising rapidly at this time in Burmah and Arakan; the rise due to the oscillatory changes, going on at the time over the whole of India, being supplemented by the rise due to the northward motion of the cyclonic vortex in the north of the Bay. This produced a greater than the average increase of pressure over this area, just as it gave rise to a diminished increase in Bengal. The increase, during the preceding 24 hours, was greatest at Diamond Island, where it amounted to ·142 inch. The only land stations where the effect of the advance of the cyclonic vortex was greater than that of the general oscillatory changes, were Saugor Island and Jessore. The pressure, at 10 A.M., at these stations, was ·01 inch less than it was on the 20th at the same hour.

The westerly winds, at the coast stations of the Arabian Sea, were considerably feebler than they had been for some days, and were now slightly below their normal strength.

Easterly winds prevailed over the Gangetic valley, westwards to Patna. Beyond this, was a region of calms and light winds. At Allahabad, Benares, and Lucknow, calms were registered at 10 A.M. To the west of these stations, the winds, although light, indicated a westerly motion of the lower atmosphere. The skies were partially clouded, westwards, as far as Lucknow, Bareilly and Agra. Beyond that, at Roorkee, and in the Punjab, Sind and the greater part of Rajputana, they were quite clear.

There was now a well-marked cyclonic motion in Bengal towards the area of depression, as indicated by the wind returns of the coast stations at the head of the Bay. In the northerly and westerly quadrants, the winds were light; but, in the southerly quadrant, they were of considerable intensity. Rain continued to fall, in moderate amounts, over nearly the same areas as on the previous day. In Western and Central India, the amount and distribution of the rainfall is roughly indicated by the following :—

	Inches.
Jubbulpore	1·35
Nagpur	1·27
Khandwa	0·59
Akola	1·07
Bombay	1·23

In the North-Western Provinces, moderate rain fell in the eastern districts, more especially in the Allahabad, Azamgarh, Mirzapore, Basti and Gorakhpur divisions.

No rain fell in the western districts. The amount and distribution is roughly shown by the following return of rainfall:—

District.	Rainfall of the sudder station.	Average for District.
	Inches.	Inches.
Jaunpore	2·0	1.1
Azamgarh	2·9	0·7
Mirzapore	0·4	0·7
Gorakhpur	0·5	0·7
Basti	5·0	2·7

Rain also fell over the coast area of the Bay of Bengal from Ganjám to Rangoon. The amount, however, was comparatively small.

The weather, generally, over the whole of Northern India, was sultry, with very light winds.

Meteorology of Bengal and the coast area of the Bay on the 21st of September.—The following table gives the meteorological observations, taken at stations on and near the coast of the Bay of Bengal, on the 21st of September:—

Stations.	Barometer 10 A.M.	Barometer reduced to sea-level.	Change since previous day.	Wind direction. 10 A.M.	Wind direction. 4 P.M.	Mean direction of wind for September.	Wind velocity. Number of miles previous 24 hours.	Wind velocity. Average for past years.	Wind velocity. Ratio of amount of wind to average amount expressed as a percentage.	Amount of cloud, 10 A.M.	Amount of Rainfall.
Nancowry . . .	29·862	29·941	+·083	SW	SW	S 52° W	380·3	241·0	157·8	6	0·06
Port Blair . . .	29·803	29·866	+·083	W	SW	S 40° W	393·0	235·6	166·8	6	0·06
Diamond Island .	29·777	29·819	+·142	WSW	SSW	S 43° W	762·0	167·0	456·3	6	0·14
Akyab . . .	29·683	29·704	+·080	SE	S	S 7° E	178·0	70·3	253·2	9	1·26
Chittagong . . .	29·566	29·655	+·021	SSE	SSE	S 27° E	13·3	109·2	12·2	10	0·33
Dacca	29·604	29·630	+·035	S	ESE	S 78° E	54·0	115·0	46·9	10	0·20
Jessore . . .	29·567	29·601	—·008	E	E	S 23° E	16·0	79·0	20 3	10	1·82
Berhampore . .	29·571	29·669	+·027	ENE	NNW	S 45° E	44·5	86·1	51·6	9	0·75
Silchar . . .	29·560	29·646	+·035	E	NE	S 49° W	76·2	64·9	117·4	8	...
Goalpara . . .	29·277	29·657	+·009	E	E	S 68° E	91·0	90·8	100·0	9	...
Sibsagar . . .	29·337	29·664	+·019	ENE	ESE	N 62° E	71·6	61·8	115·9	5	...
Purneáh . . .	29·512	29·635	+·016	E	E	S 79° E	54·0	63·0	85·7	3	0·10
Durbhanga . .	29·487	29·651	+·031	ENE	WSW	S 87° E	47·5	91·8	51·7	5	0·10
Patna	29·459	29·637	+·041	E	E	S 84° E	25·3	62·5	40·5	6	0·56
Gya	29·168	29·642	+·041	N	NE	S 78° E	30·0	54·8	54·7	6	0·27
Hazaribagh . . .	27·651	29·631	+·014	NNE	N	S 57° E	85·7	168·7	50·8	7	0·26
Burdwan . . .	29·525	29·623	+·011	E	E	S 30° E	64 3	80·9	79·5	10	...
Calcutta (Alipore) .	29·605	29·627	+·015	E by N	ENE	S 27° E	110 0	121·7	90·4	10	0 13
Saugor Island . .	29·593	29·599	—·011	NE	N	S 8° W	207·9	221·2	94·0	10	0·42
False Point . . .	29·611	29·626	+·010	WSW	SW	S 32° W	145·8	167·1	87·3	9	0·50
Cuttack . . .	29·548	29·629	+·001	W	WSW	S 7° W	48·7	61·2	79·6	7	...
Vizagapatam . .	29·663	29·694	+·054	WNW	W	N 83° E	8·7	56·3	15·4	8	...
Masulipatam . .	29·706	29·716	+·027	W	?	N 85° W	...	...	...	2	...
Madras . . .	29 781	29·803	+·026	SW	...	S 31° W	234·0	157·9	148·2	4	...

The preceding observations show that the barometer was rising at all stations, with the exception of Saugor Island and Jessore. The increase of pressure was generally small in amount, except at the east coast stations of Akyab, Diamond Island, and at Port Blair and Nancowry. The common change, at this time, was evidently one of a slow rise of the barometer, of about ·03 inch, during the preceding 24 hours. At the east and south-east stations, this small rise was supplemented by a large rise, due to the northward retreat of the cyclonic vortex; while at Saugor Island and Jessore, the opposite effect of a diminution of pressure, produced a fall of the barometer, larger in amount than the general rise.

The air motion to the south of the cyclonic vortex, *i. e.*, over the centre and south of the Bay, as shown by the anemometric returns of Akyab, Diamond Island, Port Blair and Nancowry, was, as on the preceding day, very considerably above the average; and indicated a strong influx to the cyclonic centre, from the southern and eastern quadrants. Thus, at Diamond Island, 762 miles of wind were recorded, at 10 A. M., for the preceding 24 hours; an amount four and a half times as large as the average of September. At Akyab, (to which the increased motion had now extended,) 178·3 miles were registered; the September average wind velocity being 70·3 miles per diem. To the north of the cyclonic vortex and area, the wind returns present the same features as for the preceding four days. Excepting in Assam, (where they had increased in intensity, and were now slightly in excess of their average force), the winds were, at all stations, considerably below their normal strength. This feature of diminished air motion was, as hitherto, most strongly developed in South-Eastern Bengal. Thus, the amount of wind, registered at Chittagong, was only 12·2 per cent. of its average amount; at Dacca, it was 46·9 per cent.; and, at Jessore, only 20·3 per cent. At the remaining stations, the wind velocities varied from 40 to 94 per cent. of their average amounts; excepting at Vizagapatam, where the air motion had been unusually feeble during the preceding 24 hours.

South-westerly winds were now blowing over nearly the whole of the Bay. In Southern Bengal, the wind directions at Saugor Island, Calcutta, Burdwan, Hazaribagh, Berhampore, Jessore, Dacca and Chittagong, all indicate participation in a general motion of convergence to a centre, south of the Bengal Coast. Further to the west, in the Gangetic plain, above Behar, the directions of the winds suggest that the influence of the cyclone had not modified the general character of the lower atmospheric currents there, in any appreciable degree.

The sky was now overcast at Chittagong, Dacca, Jessore, Calcutta, Saugor Island and Burdwan, that is, over the head of the Bay and the whole of Southern Bengal. It was, moreover, rapidly clouding over the northern and central districts of Bengal and in Assam, while in Behar and Chutia Nagpore, the weather was still fine, with passing clouds.

The amount of rain, registered on the 21st, at Nancowry, Port Blair and Diamond Island, was small. The area of rainfall had in fact advanced considerably north of these stations, and was now rapidly extending over Bengal. Moderate rain fell in all the divi-

sions of Bengal, except the Burdwan and Rajshahye divisions. The average amount of the fall, for each division, is given below :—

Divisions.	Number of Stations.	Average rain fall of preceding 24 hours.
		Inches.
Burdwan	18	0·11
Presidency	19	0·48
Rajshahye	17	0·09
Cooch Behar	6	0 32
Dacca	14	0·38
Chittagong	12	0·53
Patna	24	0·25
Bhaugulpore	17	0·25
Orissa	13	0·33
Chutia Nagpore	9	0 63

giving an average of ·34 inch or one-third of an inch for the whole province.

Meteorology of the Bay of Bengal on the 21st of September.—The following table gives, in a brief form, all the meteorological information contained in the logs of the vessels for the 21st of September :—

Name of Ship.	Latitude at noon.	Longitude at noon.	Wind.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
Camona . . .	1° 45′ N.	86° 15′ E.	4 A.M., W. S W. 4.	29·84		Force of wind 4.
			Noon, W. S. W. 3.	29 86		Do. do 3.
			4P.M., W.S.W.	29 84		Do. do 3 to 6.
			Midnight, W. S. W. 3 to 6.	29·86	..	A sharp squall struck the ship just at midnight.
Loch Etive . . .	14° 14′ N.	87° 25′ E.	Morning, S. W. Afternoon, W. S. W. Midnight, S. W.	Noon, 29·68	29·75	Morning—Fresh steady winds and cloudy weather. 4 P. M.—Weather assuming a very threatening appearance with heavy wild-looking clouds to the north, north-west. 8 P. M.—Banks of cloud still to north, north-west, but beginning to break up. Midnight—Fresh south-west wind; clouds breaking up and clearing.
Fazel Kurreem . .	15° 44′ N.	88° 15′ E.	...	Noon, 29·78	29·73	Very heavy rain in the morning; ship rolling much, and taking in water.
Madras . . .	...	...	...	Noon, 29·68	29·63	6 A. M.—Arrived at Chittagong; calm sultry weather, with a windy-looking sunrise. 4 P. M.—Left Chittagong. Midnight—Strong southerly breeze with passing squalls and showers.
Janet Cowan . .	16° 9′ N.	88° 38′ E.	Morning, S. W.; afternoon and evening, W.	30·25?	29·75?	Noon—Strong breeze with passing showers. 0-30 P. M.—Strong breeze with heavy squalls and showers of rain; a heavy squall struck the ship carrying away

Name of Ship.	Latitude at noon.	Longitude at noon.	Wind.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
						the main and mizen royal and fore-top-gallant sails. 4 P. M.—Blowing half a gale of wind with heavy rain and squalls. 9 P. M.—Moderating.
Phuttle Barry	19°5 N.	88° 13′ E.	Morning, W. S. W. 4 P.M., S. W.	Noon, 29·90	29·65	Morning—High sea running, with dark cloudy weather; strong breezes with drizzling rain and much lightning. 8 P. M.—Weather clearing up with a fair sky. Midnight—Light breeze and fine weather.
First Lancashire	19° 7′ N.	90° 4′ E.	W. to W. S. W.	Noon, 29·38 4 P.M, 29·45	29·53 29·60	Fresh and squally breezes with heavy rain during the day. 8 P. M.—Weather cleared to north-east (as the mean current of air was from east to north-east (?))
Bates Family	Off Sangor Island		N. E.	29·63	29·53	Fine wind with cloudy sky.
Satara	...	...	N. W. to S. S. W.	29·24 to 29·38	29·44 to 29 58	Violent squalls of wind and rain; frightful cross sea; barometer very unsteady.
Moulmein	Passing down river Hooghly on voyage to Chittagong.		Morning, N.E. 1-30 P. M., S. E.	Noon, 29·78	29·60	Morning—Heavy rain and squalls from north-east. 8 30 A. M.—Discharged pilot. Noon—Strong breeze and rain. 1-30 P. M.—Sighted Mutlah light vessel; weather squally; rain and heavy cross sea; experienced a strong current setting westerly (about 2½ knots per hour).
				Midnight, 29·70	29·52	Midnight—Very dark and cloudy, with frequent heavy squalls, attended with thunder and lightning; heavy cross sea running; wind very variable.
Racilia	Off Kedgeree		N. E.	...	...	Moderate breeze from north-east; sky cloudy.
Amelie	18° 2′ N.	85° 0′ E.	...	...	...	3 A. M.—Strong wind from the west with thunder and lightning which continued until 8 A. M. 8 A. M.—Strong and increasing winds from south-west with torrential rain; rain, heavy and continuous, continued to fall during the day; sudden squalls from the north; the wind continued from that direction for two or three minutes; this was followed by an interval of calm; after which the winds came suddenly from the south with great force; for about 15 or 20 minutes the winds made the turn of the compass. The squalls, which lasted hardly ten minutes from each direction, were as violent as in a cyclone. The barometer descended to 29·61 during the squalls. After the squalls passed away, the winds returned to south-west; fine winds, and sea somewhat high.
Meteor L. V.	Intermediate station in Gaspar Channel.		4 A.M., N. E.	29·70	29·50	Moderate winds and cloudy.
			8 A.M., N. E.	29·76	29·56	Moderate winds and drizzling rain.
			Noon, N. N. E.	29·70	29·50	Moderate winds and cloudy.
			4 P.M., N. N. E.	29·64	29·44	Light winds and cloudy.
			8 P.M., S. W.	29·70	29·50	Overcast, squally with rain.
			Midnight, S. W.	29·66	29·46	Hard squalls with rain.

Name of Ship.	Latitude at noon.	Longitude at noon.	Wind.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
Cassandra, P. V.	...	...	4 A.M., E., (3.)	...	...	4 A. M.—Heavy squall from east with rain.
			10 A.M., N. N. E., (4.)	29·70	29·52	9·55 A. M.—Blowing fresh from north, north-east with high sea.
			4 P.M., N. N. W., (3.)			
			6 P.M., S. S. W., (4.)	29·63	29·45	8 P. M.—Blowing hard from west with incessant heavy gusts accompanied with rain.
			8 P.M., W. N. W., (4.)	29·64	29·46	
			10 P.M., W., (6.)	29·61	29·43	Midnight—Moderate gale, accompanied with rain squalls.
			Midnight, W., (7.)	29·50	29·42	
Mermaid, L. V.	At Mutlah Station		4 A.M., N.	29·60	29·50	2 A. M.—Heavy rain and dark cloudy weather with threatening appearances.
			8 A.M., N.N.E.	29·61	29·51	8 A. M.—Fresh breeze and rain.
						9 A. M.—Sea and wind increasing.
						10 A. M.—Wild appearance from north, north-east through east to south.
			Noon, N.N.E.	29·60	29·50	Noon—Heavy squalls; thunder, lightning and heavy rain.
						2 P. M.—Fresh gale and heavy rain.
			4 P. M., N.	29·50	29·40	3. P. M.—Heavy squalls, wind and sea increasing.
						5 P. M.—Squally with confused sea.
						6 to 9 P. M.—Wind veering round from west to south with heavy rain.
			8 P.M., W.	29·54	29·44	9 P. M.—Wind veering from north to west with frightful gusts and heavy rain, thunder and lightning.
			Midnight, W.	29·54	29·44	11 P. M.—Heavy squalls and confused sea.
						Midnight—Strong gale and confused sea.
Canopus, L. V.	At Eastern Channel station		4 A.M., E.	29·67	29·51	4 A. M.—Light winds and cloudy weather.
			8 A.M., N. E.	29·68	29·52	8 A. M.—Moderate breeze and cloudy with rain.
			Noon, N. N. E.	29·68	29·52	Noon—Moderate breeze and cloudy, with squally looking weather.
			4 P. M., N. N. W.	29·60	29·44	
			8 P.M., W. N. W.	29·65	29·49	4 P. M.—Moderate breeze, and dirty-looking weather.
						8 P. M.—Blowing a gale, and dirty-looking weather.
			Midnight, W. S. W.	29 62	29·46	Midnight—Blowing a gale with a heavy sea; barometer very unsteady.
Chinsurah, P. V.	Buoy Station		4 A.M., W. S. W.	...	...	4 A. M.—Squally.
			8 A.M., S. W. by S.	...	...	8 A. M.—Hard squalls with heavy rain; force of wind 4 to 8.
			Noon, S. W. by S.			
			4 P.M., S. W.	...	...	7 P. M.—Heavy squalls of wind and rain.
			9 P.M., S.	...	...	9 P. M.—Weather moderating; force of wind 4.
Lugar of Ayr	20° 59′ N	88° 58′ E	Variable ...	29·26	29·51	4 A. M.—A deluge of rain, but little wind.
						8 A. M.—Strong and increasing gale with high sea.
			Afternoon W. to N. W.	...	...	Noon—Very heavy confused sea.
			Force 9 to 10	...	...	Evening—Hard gale and furious squalls.

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Probable corrected reading of barometer.	Remarks on weather.
Comet, L. V.	At Lower Gaspar Station		4 A.M., E.	...	...	4 A. M.—Light airs and calms.
			8 A.M., N.	29·67	29·57	8 A. M.—Light breeze and squally appearance to the southward.
			Noon, N. E.	29·64	29·54	Noon—Dull heavy appearance to the southward.
			4 P.M., N. E.	29·60	29·50	6. P. M.—Light breeze and heavy rain.
			8 P.M., N. N. W.	29·62	29·52	8 P. M.—Freshening wind, thunder and heavy rain.
			Midnight, N. W.	29·61	29·51	Midnight—Strong breezes and heavy rain.
Foam, L. V.	At Upper Gaspar Station		4 A M., N.	29·78	29·53	4 A. M.—Moderate breeze and fine clear weather.
			8 A.M., N. N. E.	29·85	29·60	8 A. M.—Light winds and fine with gloomy appearance.
			Noon, N.	29·75	29·50	Noon—Light winds and fine with cloudy overcast sky and rainy appearance to the eastward.
			4 P.M., N.	29·67	29·42	4 P. M.—Fresh breeze and windy looking sky.
			8 P.M., N.W.	29·75	29 50	8 P. M.—Light winds; dark threatening appearance.
						9-15 P. M. to 10-30 P. M.—Squally with passing showers.
			Midnight, W. S. W.	29·75	29·50	10-30 P. M. to midnight.—Hard squalls with heavy rain; heavy sea from the southward.

The cyclonic vortex, which had formed on the 17th, 18th and 19th, was now advancing northwards to the coast of the Sunderbuns, east of Saugor Island.

In the centre of the Bay, to the west of the Andamans, the ship *Loch Etive* experienced a moderate wind from the west-south-west, with fine weather until the evening. At 4 P. M., when she was probably in latitude 15° N., heavy clouds were observed to the north, and the weather assumed, for some time, a threatening appearance. The clouds, however, gradually dispersed; and, early next morning, she had strong breezes and cloudy weather.

The *Fazel Kurreem* (in latitude 15° 44′ N. at noon) had very heavy rain in the evening, and was probably on the borders of the area of rainfall and of atmospheric disturbance. The *Janet Cowan*, in latitude 16° 9′ N. at noon, or at a short distance further north, had a strong breeze with heavy squalls of rain at noon, and the wind increased for some time; and at 4 P. M., was blowing a gale with heavy rain squalls. The logs of these three vessels, together with the observations taken in Ceylon and at the Andamans and Nicobars, show that over the whole of the south and centre of the Bay, to latitude 15° N., south-west monsoon winds continued, with the same general strength and character, as during the previous three days. The skies were clouded, the winds strong, and occasional heavy showers of rain probably fell, but there was no large atmospheric disturbance or heavy continuous rainfall over this part of the Bay. Over the greater part of the north of the Bay, from the Arakan and Burma Coast across to the Orissa and Ganjam Coasts, heavy rain was now falling, and the rainfall was apparently heaviest in the northward prolongation of its previous direction of motion. The *Lugar of Ayr*, *First Lancashire* and *Moulmein*,

and probably the *Satara*, were all in the neighbourhood of the line of the storm centre during the day. The *Moulmein* had heavy rain and squalls from the north-east during the day. The *Satara*, which was apparently in about latitude 19° or 20° N. at noon, states that she experienced violent squalls of wind and rain. The *Lugar of Ayr*, in latitude 20° 57′ N by account, had a deluge of rain in the morning and constant rain at noon. The rain apparently continued all day, and at midnight it was blowing a hard gale, with occasional furious squalls.

The logs of the light vessels and pilot vessels show that, early on the morning of the 21st, off the mouth of the Hooghly, light to moderate winds (force 1 to 3), varying from north to east, were blowing. The winds gradually increased in strength, and were accompanied, during the morning, with frequent rain squalls. The wind continued to blow from the north-east to north-north-west, with strength 3 to 4, until late in the afternoon. Between 6 and 7 P.M., the wind was shifting round to the west; and about 8 P.M., it blew very heavily from that direction, with heavy rain. During the remainder of the night, there was a strong gale, the wind occasionally coming down in frightful gusts. There was also a very heavy confused sea running at this time. As the wind veered round to west and west-south-west about 8 P.M., it is probable that the storm centre advanced across the coast late in the evening of the 21st, probably about 10 P. M., and, so far as can be judged from the wind directions, it struck the coast about 30 or 40 miles to the east of Saugor Island.

As has already been stated in the discussion of the meteorology of the land area, the weather, in Bengal, was generally very similar to what it had been for the past three or four days. The barometric differences were unusually small, the winds were light, but had veered round to the north, indicating that they were participating in the general cyclonic circulation, due to the advancing storm. The sky was also overcast, the weather gloomy, and occasional showers fell during the day, in the south of of the province, giving moderate rain to the Presidency division.

The general atmospheric conditions were, thus, similar to what they had been during the past three days. Over the greater portion of the Bay, from the equator to latitude 15° N, there were strong steady winds and high baric gradients. Over Bengal, the barometer was nearly uniform, the winds light and somewhat unsteady, but generally indicating the existence of a cyclonic vortex to the south. Between these two regions of opposed meteorological conditions, there was a considerable area in the north of the Bay, over which heavy continuous rain fell. This area, owing to the rapid atmospheric circulation, accompanying and produced by the heavy concentrated rainfall, had become an area of barometric depression and of cyclonic circulation. The weather over the area was of the usual character. It should, however, be carefully remarked that, the strong winds were only found in the southern and eastern quadrants of the vortex. On the northern quadrants, the winds were comparatively feeble, at a short distance, probably not more than 40 miles, from the centre. This is indicated very clearly by several of the logs. For example, the *Bates Family*, off Saugor Island, had a fine wind with clouded sky during the day. The *Racilia*, which anchored off Kedgeree on the Hooghly River in the evening, experienced moderate breezes during the day. The *Phuttle Barry*, which was in the neighbourhood of the mouth of the Hooghly, states that the weather

was clearing up with a fair sky at 8 P.M., and that, at midnight, she experienced light breezes and fine weather.

The contrast between the character of the weather on the north and south quadrants is as marked as the difference between the atmospheric conditions to the north and south of the cyclonic area.

Meteorology of the 22nd of September (Vide Plate VI).

Meteorology of India on the 22nd of September.—The meteorology of the Indian area was now mainly dependent upon the motion of the Bay of Bengal cyclonic vortex.

The changes of pressure during the previous 24 hours were very considerable. Pressure was diminishing rapidly at this time in Bengal, more especially at the southerly stations. It was, on the contrary, increasing in Arakan and Burma. These changes of course accompanied the northward motion of the vortex.

Over the remainder of India, more especially in the Punjab, Sind, Rajputana, the North-Western Provinces, the Central Provinces and Behar, the barometer was falling. The decrease in the Punjab was almost as large, during the preceding 24 hours, as in Southern Bengal. This fall was, however, probably due mainly, if not entirely, to the ordinary oscillatory changes continually in progress over the Indian area; and which usually are greatly exaggerated in the Punjab, compared with the rest of India. This exaggeration is evidently due to its geographical position and its small magnitude, compared with the lofty Himalayas and the broken table-land of Afghanistan, which surround it and influence its meteorology. Pressure was either steady or slowly increasing in the Bombay and Madras Presidencies.

Over the north of the Bay and the adjacent land area, including Arakan, Bengal, Assam, and Chutia Nagpore, the wind directions indicate the normal convergence to a cyclonic centre. In this portion of India, the winds were very strong and considerably above their mean strength. Elsewhere, the winds were generally light. Over the greater part of the peninsula and in North-West India, winds varying between north-west and south-west prevailed, indicating that the ordinary monsoon current was still in existence. At Patna, the wind was from east at 10 A. M., and at Durbhanga from east-south-east, while at Allahabad, Lucknow, Benares and Gya, calms were registered. This shows that the monsoon current up the Gangetic valley was now suspended, although there was no direct participation in the cyclonic circulation. Hence the wind distribution in Northern India indicates plainly that the area, already mentioned, defined strictly the portion of the lower atmosphere, affected directly by the cyclonic disturbance.

Except in Bengal, the rainfall recorded on this day, was small in amount. Little or no rain fell over the Central and Western Districts of the North-Western Provinces, Oudh, the Punjab, Rajputana, the North Districts of Bombay and the Central Districts of the Deccan. Local showers fell at a few stations in Western India. Hence the rainfall at this time, except in connection with the Bengal cyclonic vortex, was small in amount and local in distribution and character.

Meteorology of Bengal and the coast area of the Bay of Bengal on the 22nd of September.—The following table gives meteorological observations taken in Bengal and the coast area of the Bay of Bengal on the 22nd of September:—

Stations.	Barometer, 10 A.M.	Barometer reduced to sea-level.	Change since previous day.	Wind direction.		Mean direction of wind for September.	Wind Velocity.			Amount of cloud, 10 A.M.	Rainfall.
				10 A.M.	4 P.M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Nancowry . . .	29·898	29·978	+·036	SW	SW	S 52 W	268·6	241·0	111·5	9	0·12
Port Blair . . .	29·852	29·915	+·049	SW	W	S 40°W	270·0	235·6	114·6	6	0·04
Diamond Island . .	29·832	29·873	+·055	SSW	SSW	S 43°W	234·6	167·0	140·5	6	0·05
Akyab	29·741	29·762	+·058	S	SW	S 7°E	183·0	70·3	260·3	10	1·04
Chittagong . . .	29·578	29·668	+·012	SSE	SSE	S 27°E	71·8	109·2	65·7	10	1 28
Dacca . . .	29·489	29·525	−·115	S	S	S 78°E	327·0	116·0	284·3	9	0·18
Jessore . . .	29·425	29·458	−·142	S	SE	S 23°E	612·0	79·0	774·7	10	2·44
Berhampore . . .	29·421	29·521	−·150	NNE	N	S 45°E	130 5	86·4	151·0	10	1·88
Silchar	29 571	29·659	+·011	E	WNW	S 49°W	62·6	64·9	96·5	10	1·15
Goalpara . . .	29·273	29·661	−·004	E	E	S 68°E	295·0	90·8	324·9	10	2·07
Sibsagar . . .	29·403	29·737	+·066	NE	NE	N 62°E	63·0	61·8	101·9	10	0·03
Purneah . . .	29·466	29·592	−·046	NE	ENE	S 79°E	104·0	63·0	165·1	7	0·64
Durbhanga . . .	29·423	29·589	−·064	E	ENE	S 87°E	90·0	91·8	98·0	8	0·16
Patna	29·414	29·593	−·045	E	E	S 84°E	19·7	62·5	31·5	6	0 05
Gya	29·203	29·581	+·035	Calm	Calm	S 78°E	2C·0	54·8	36·6	10	1·51
Hazaribagh . . .	27·598	29·583	−·053	NNE	S	S 57°E	93·3	168 7	55·3	9	...
Burdwan . . .	29·378	29·478	−·147	NW	W	S 30°E	183·5	80·9	226 8	10	3·80
Calcutta (Alipore) .	29·445	29·466	−·160	SW	SW by S	S 27°E	361·0	121·7	295·6	10	6·20
Saugor Island . .	29·558	29·564	−·035	WSW	SW	S 8°W	568·8	221·2	257·1	10	2·41
False Point . . .	29·604	29 619	−·007	WSW	SW	S 32°W	254·2	167·1	152·0	10	0·56
Cuttack . . .	29·549	29·630	+·001	SW	SSW	S 7°W	69·4	61·2	113·4	8	0·13
Vizagapatam . . .	29·667	29·699	+·004	NW by W	SW	N 83°E	31·3	56·3	55·6	10	0·20
Masulipatam . . .	29·704	29·714	−·002	W	...	N 85°W	...	...	...	7	0·05
Madras	29·800	29·822	+·019	S by W	...	S 31°W	158	157·9	100·1	6	0·01

The barometric changes of the 24 hours, preceding 10 A.M. of the 22nd September, over the land area represented by the preceding observations, were mainly dependent on the progressive motion of the cyclonic vortex. The barometer was steady at stations along the west coast of the Bay. In the east of the Bay, (as shown by the observations at Nancowry, Port Blair, Diamond Island and Akyab), the barometer was rising rather rapidly; while, in Bengal, it had fallen very considerably. The centre of the cyclonic vortex, at 10 A.M., was in Southern Bengal, and probably about 20 or 30 miles west of Jessore, and nearly midway between Calcutta and Jessore. It was, at this time, moving very slowly, and, as shown by the wind directions, was in nearly the same position at 4 P.M.; the station of Berhampore being, at that hour, as at 10 A.M., in the northern quadrant of the cyclone. The air motion in the south and centre of the Bay, as indicated by the anemometric returns

of Port Blair, Diamond Island, Akyab, Madras, was as hitherto, above the average; and strong south-west monsoon winds continued over the whole of the Bay. The only districts represented by the observations in the table, where the wind velocity was still below the average, were Behar and Chutia Nagpore. In Behar, which apparently did not participate in the cyclonic motion, the winds, although still easterly, were much feebler than they had hitherto been, owing to the cyclonic eddy in Bengal. The wind velocity was now only from one-half to one-third its normal amount. Calms were registered at Gya. Over the whole of Bengal and Assam, during the day, the air motion was very considerably in excess of its average amount. Thus at False Point, Saugor Island, Calcutta, Burdwan, Berhampore, Dacca, and Akyab, the amount of wind, registered for the previous 24 hours, was from one and a half times to three times the average amount of September. At Jessore, which, at this time, was probably the nearest observing station to the centre of the cyclonic eddy, and on the eastern quadrant, (usually the quadrant of maximum air motion in Bengal cyclonic storms,) 612 miles of wind were registered at 10 A.M.; giving an average of nearly 26 miles per hour for the preceding 24 hours. This amount is very nearly eight times the average velocity of the wind at Jessore in September.

The sky had now become overcast over the whole of Bengal, (excepting the north-western districts) and along the Orissa Coast, and heavy rain was falling over Arakan, Bengal, Assam and Orissa. The area of concentrated heavy rainfall was confined to a narrow belt, lying in a somewhat curved line, running nearly north and south. The rainfall was moreover, so far as can be judged by the returns, heaviest, at this time, on the western quadrant of the cyclone, and to a somewhat less extent along its line of march; while the eastern quadrant, as has been pointed out, was characterized by the greatest wind velocity. The following table gives the average rainfall in the various divisions of the province of Bengal, for the 24 hours preceding 6 P.M. of the 22nd :—

PROVINCES.	DIVISIONS.	No. of stations.	Average rainfall.
			Inches.
Bengal	Burdwan	18	5·78
	Presidency	29	2·90
	Rajshahye	17	1·13
	Cooch Behar	6	0·83
	Dacca	14	0·76
	Chittagong	12	2·03
Behar	Patna	24	0·45
	Bhagulpore	17	0·84
Orissa	Orissa	13	0·71
Chutia Nagpore	Chutia Nagpore	9	0·89

or an average of very nearly 2 inches for the whole province, including an area of 192,000 square miles.

Rainfalls exceeding 5 inches in amount were registered at the following stations at 6 P.M. on the 22nd :—

	Inches.		Inches.
Baraset	12·32	Serampore	14·32
Calcutta	6·28	Hooghly	8·40
Alipore	6·64	Ghatal	11·08
Dum-Dum	7·90	Roypore	6·62
Barrackpore	14·87	Hetampore	7·50
Howrah	5·60	Jehanabad	8·77
Moheshrakha	8·23		

The first nine stations were all near the cyclonic centre, during the day, but were probably all, as Calcutta certainly was, some little distance to the west of the path of the centre, during its northward motion. The last four stations are in the Burdwan division, which received exceptionally heavy rain at this time. These stations were all at considerable distances to the west of the path of the cyclonic centre.

Meteorology of the Bay of Bengal on the 22nd of September.—The following table gives the whole of the meteorological information contained in the logs of the vessels for the 22nd of September:—

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Barometer probable corrected reading.	Remarks on Weather.
Camona	5° 4′ N.	86° 24′ E.	4 A. M., W. S. W.	29·86	...	8 A.M.—A sharp gust came without any indication and carried away fore-top-gallant mast, &c.; no rain fell.
			Noon, S. W.	29·86	...	Remainder of day—Moderate, steady wind and clear.
			4 P. M., S. W.	29·84	...	Force of wind 3 to 7.
			Midnight, W. S. W.	...	...	Force of wind 6.
Loch Etive	16° 56′ N.	88° 34′ E.	S. S. W. Evening, S.W. to S. S. W.	Noon, 29·72	29·74	Morning—Moderate breezes and cloudy. Noon—Fresh and cloudy. 6 P.M.—Fresh breezes from south-west with very heavy clouds and much lightning in the north-west. Midnight—Much lightning and distant rumbling thunder in the north-west.
Fazel Kurreem	18° 2′ N.	88° 16′ E.	S. W.	Noon, 29·72	29·67	Sky cloudy; very heavy sea.
Madras	On voyage from Chittagong to Calcutta.		...	29·60 (?) Reading of an aneroid.	29·53?	Morning—Increasing gale, the wind suddenly hauling to south-south-west, and south-west by south. A most confused irregular sea. Ship labouring very much. 2 P.M.—Sudden shift of wind to north-west. Blowing very hard with blinding rain, and a most confused sea. Evening—Wind settled to south-west by south with dry clear starlight.
Satara	Approaching the Sandheads.		1 A. M.—Wind variable.	1 A. M., 29·30	29·55	1·30 A.M.—A sudden squall struck the ship with violent force from the north-west, lasting until 3·30 A.M. Very high sea. 3 A.M.—Wind and weather moderating.
	...	...	...	Noon, 29·32	29·57	Noon—Fresh gale; sounded 35 fathoms. Midnight—Heavy squalls of wind and rain with lightning and thunder.
First Lancashire	19° 40′ N.	89° 49′ E.	W. S. W. to S. W.	29·40	29·55	Wind and weather very unsettled. Fresh gale with heavy rain for a few hours followed by calms and variable winds. Sky dull and gloomy.
Janet Cowan	19° 39′ N.	88° 52′ E.	S. W. by W.	30·20?	29·60?	2 A.M.—Strong squalls with rain. 8 A.M.—Very dirty weather; heavy squalls with rain. Noon—Brisk breeze and squally.
Phuttle Barry	20° 28′ N.	88° E.	Morning, S.W. Afternoon, S. S. W.	29·90	29·60	Morning—Fair breeze and fine weather, but somewhat cloudy with drizzling rain. 8 P.M.—Weather unsettled and cloudy.
Bates Family	... Proceeding up the river.			29·50	29·40?	Heavy squalls of wind and rain from south to west.

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Barometer probable corrected reading	Remarks on Weather.
Lugar of Ayr	20° 9′	88° 28′	W. to S. W. Force 8 to 10.	29·35	29·60	Morning—Very heavy gale; thick rain; furious squalls. Evening—Blowing hard with fierce squalls and heavy rain.
Moulmein	...	...	Morning, S. by W.	4 A. M., 29·76	29·56	Early Morning—Hard squalls and gale with high cross sea.
				Noon, 29·68	29·48	Noon—Hard gale and high sea; sea increasing and sky threatening.
			2 P. M., S. W.	...	...	2 P.M.—Very heavy gale; sea continually filling the decks. 5·20 P.M.—Heavy squalls from the south-east with rain, lightning and thunder, and high cross sea.
			Midnight, S. W.	Midnight, 29·58 (?)	...	Midnight—Wind south-west; heavy squalls from south-east.
Meteor, L. V.	Intermediate Station in Gaspar Channel.		4 A. M., S. W.	29·66	29·50	4 A.M.—Squally with heavy rain.
			8 A. M., S. W.	29·74	29·58	8 A.M.—Strong breeze and overcast.
			Noon, W. S. W.	29·74	29·58	Noon—Strong winds and heavy rain squalls.
			4 P. M., S. W.	29·68	29·52	4 P.M.—Fresh and overcast.
			8 P. M., S. W.	29·76	29·60	8 P.M.—Fresh and overcast.
			Midnight, S. W.	29·70	29·54	Midnight—Fresh and overcast.
Cassandra, P. V.	...	...	4 A. M., S. W.	29·70	29·52	4 A.M.—Moderate gale from south-west; heavy squalls and rain.
			8 A. M., S. W.	29·73	29·55	Force of wind 5 to 6.
			Noon, S. W.	29·75	29·57	Noon—Blowing hard from the south-west.
			4 P. M., S. W.	29·65	29·47	Force of wind 3 to 4.
			Midnight, S. W. by W.	29·82	29·64	Force of wind 3 to 4.
Mermaid, L. V.	At Mutlah Station.		4 A. M., W. by S.	29·55	29·51	1 A.M. to 5 A.M.—Strong gale and dark weather; cloudy with very heavy squalls of rain.
			10 A. M., W.	8 A. M., 29·59	29·55	6 A.M. to 9 A.M.—Strong gale; cloudy and squally with heavy sea.
	...	...	Noon, W. S. W.	29·60	29·56	10 A.M. to 1 P.M.—Terrific squalls and heavy rain with high sea.
			4 P. M., S. W.	29·58	29·54	1 P.M. to 5 P.M.—Strong gale with terrific squalls, and rain accompanied with thunder and lightning. 5 P.M.—Moderating. 8 P.M.—Fresh gale and squally.
			Midnight, S. W.	29·64	29·60	11 P.M.—Srong gale and heavy sea; sky dark and gloomy.
Canopus, L. V.	Eastern Channel Station.		4 A. M., W. S. W.	29·62	29·46	4 A.M.—Strong breeze and very dirty-looking weather.
	...	...	8 A. M., W. S. W.	29·67	29·51	8 A.M.—Fresh breeze with hard squalls and rain.
			Noon, S. W.	29·69	29·53	Noon—Blowing in hard squalls with a very heavy sea on and dirty-looking weather.
			4 P. M., S. W. by S.	29·63	29·47	4 P.M.—Weather moderating a little.
			8 P. M., S. W.	29·70	29·54	
			Midnight, S. S. W.	29·72	29·56	Midnight—Strong breeze with still a heavy sea on.

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Barometer probable corrected reading.	Remarks on Weather.
Comet, L. V.	At Lower Gaspar Station.		4 A. M., W. S. W.	29·60	29·50	1 A.M.—Strong gale from the west with lightning, thunder, and heavy rain. 4 A.M.—Strong gale with continuous rain; heavy south-west swell.
			8 A. M., W.	29·62	29·52	10 A.M.—Gale decreasing; sky overcast.
			Noon, W. by S.	29·67	29·57	
			4 P. M., to midnight, W. S. W.	29·67 to 29·70	29·57 to 29·60	4 P.M.—Fresh breeze and cloudy. Midnight—Fresh breeze and light overcast sky.
Foam, L. V.	At Upper Gaspar Station.		4 A. M., W. S. W.	29·71	29·51	Midnight to 3 A.M.—Strong breeze, hard squalls with rain, heavy sea from south-south-west. 4 A.M.—Hard gale with violent squalls and high sea. 6 A.M.—Fresh gale and hard squalls with rain.
			8 A. M., W.	29·80	29·60	6 A.M. to 10-30 A.M.—Weather moderating.
			Noon, W.	29·75	29·55	10-30 A.M. to 2 P.M.—Fresh gale, stormy rainy appearance, with heavy confused sea. 2 P.M. to 4 P.M.—Fresh breeze and cloudy, squally, rainy appearance.
			4 P. M., to midnight, S. W.	...	...	4 P.M. to 8 P.M.—Fresh gale, and hard squalls with rain. 8 P.M. to midnight—Fresh gale and passing rain squalls.

The majority of the vessels which supplied logs, giving information of the storm, were either passing up the River Hooghly, or were near the head of the Bay and advancing towards the Sandheads. They were all in the area where the stormy weather had originated on the 17th and 18th. The extracts from the logs prove that, south-westerly monsoon winds were again established over the whole of the Bay, and that the weather gradually improved, during the day, at the head of the Bay. In the morning, the logs of the pilot and light vessels show that the weather was squally with occasional heavy showers of rain. The *Mermaid*, light-vessel, stationed at Mutlah, experienced a strong gale with terrific squalls, and rain with heavy thunder and lightning, between 1 and 5 P.M. In the evening, the weather, although unsettled in appearance, slowly moderated. The sky was still dark and gloomy, and the sea high and confused. The centre of the cyclonic vortex, at 10 A.M. of the 22nd, was probably north-east of Calcutta, and about midway between that station and Jessore; and in the evening, was probably in the neighbourhood of Berhampore and to the south-east of it. Hence, it is evident that the rain and wind squalls continued, in the southern quadrant, to a very considerable distance south of the vortex.

There is one feature, to which it appears desirable to draw attention, as it illustrates the great irregularity in probably all cyclonic air motion on the large scale. On the 22nd, after the centre of barometric depression and of cyclonic convergence had advanced into Central Bengal, the Steam-ship *Madras*, advancing to the entrance of the Hooghly, experienced a sudden shift of wind from south-west to north-west, at 2 P.M. The Captain states, in his log book, that it blew very hard for some time, with blinding rain and a most confused sea.

The Steam-ship *Satara*, approaching the Sandheads, also passed through a similar severe squall earlier in the day. According to her log, at 1 A.M., a sudden squall struck

the ship, with violent force, from the north-west, lasting until 3-30 A.M. It was accompanied with a very high sea.

Both of these squalls appear to have been comparatively local, and different from the general cyclonic circulation, at this time established over the head of the Bay. This is shewn by the rapid change of the wind, in both cases, from south-west to north-west, and by the fact that the squall was not felt or observed by any of the numerous light-vessels and pilot brigs which were in the immediate neighbourhood of both ships.

Meteorology of the 23rd of September (Vide Plate VII).

Meteorology of India on the 23rd of September.—In Bengal the changes of pressure were considerable; elsewhere they were much smaller in amount. The barometer rose in all other districts of India, excepting Sind and Guzerat, and also, locally, at Bareilly in the North-Western Provinces. The rise of the barometer (omitting Bengal) was greatest in the Central Provinces and the Punjab; where it averaged ·05″

Very strong winds were recorded at all the Bengal stations. In the North-Western Provinces and the Punjab, and the adjacent districts of Rajputana and Central India, the winds were generally very light, and somewhat irregular in direction. In the immediate neighbourhood of the hills, south-east winds continued; but further south, in the Gangetic Doab, the winds were veering round to their cold-weather direction, (north-west or west). Thus, at Agra, the wind was west, and at Allahabad north-west. Calms were recorded at Lucknow, Jhansi, Sirsa, and Rawalpindi. Along the west coast, and in the Peninsula, the winds were normal in direction. They had, however, increased slightly in strength.

The low barometer of the previous day, in Upper India, was followed, in the afternoon of the 22nd and the morning of the 23rd, by slightly disturbed weather. Dust-storms occurred in the Trans-Indus Districts, at Peshawar and Dera Ismail Khan, and a gale of wind blew at the hill stations of Simla and Mussooree.

Little rain fell on this day, except over the area of cyclonic disturbance in North-Eastern India. Local showers occurred at several stations in the Madras and Bombay Presidencies. In Upper India, the skies were clear and the weather dry and fine.

Meteorology of Bengal and of the coast districts of the Bay of Bengal on the 23rd of September.—The following table gives observations taken in Bengal and the coast districts of the Bay, on the 23rd of September:—

Stations.	Barometer, 10 A.M.	Barometer reduced to sea-level.	Change since previous day.	Wind direction.		Mean direction of wind for September.	Wind velocity.			Amount of cloud, 10 A.M.	Rainfall.
				10 A.M.	4 P.M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Nancowry . . .	29·854	29·934	—·044	SW	SW	S 52°W	240·6	312·3	77·0	9	0·53
Port Blair . . .	29·839	29·902	—·013	W	W	S 40°W	240·0	443·0	54·2	10	0·02
Diamond Island . .	29·830	29·871	—·002	SW	WSW	S 43°W	143·4	276·3	51·9	5	...
Akyab	29·792	29·813	+·051	SW	S	S 7°E	125·0	52·0	240·4	10	1·09
Chittagong . . .	29 675	29·764	+·097	Calm	ESE	S 27°E	213·7	109·2	195·6	10	2·06
Dacca	29·588	29·624	+·099	S	S	S 78°E	395·0	115·0	343·4	9	1·50
Jessore	29·588	29·622	+·163	E	SSE	S 23°E	135·8	79·0	171·9	10	1·61
Berhampore . . .	29·518	29·618	+·097	SW	W	S 45°E	153·8	86·4	178·0	10	4·59

Stations.	Barometer, 10 A. M.	Barometer reduced to sea-level.	Change since previous day.	Wind Direction.		Mean direction of wind for September.	Wind Velocity.			Amount of cloud, 10 A. M.	Rainfall.
				10 A. M.	4 P. M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Silchar	29·673	29·762	+·102	NE	Calm	S 49°W	51·0	64·9	78·6	10	0·19
Goalpara . . .	29·251	29·641	—·022	E	E	S 68E	676·1	90·8	744·6	10	5·89
Sibsagar	29·433	29·767	+·030	E	ENE	N 62°E	96·5	61·8	156·1	10	0·22
Purneah	29·430	29·557	—·036	NE	ESE	S 79°E	172·0	63·0	273·0	9	0·04
Durbhanga . . .	29·435	29·601	+·012	E	WSW	S 87°E	53·6	91·8	58·3	9	0·17
Patna	29·428	29·608	+·014	E	E	S 84°E	21·4	62·5	39·0	10	0 28
Gya	29·229	29·611	+·026	Calm	Calm	S 78°E	20·0	54·8	36·7	10	1·67
Hazaribagh . . .	27·618	29·613	+·020	W	WNW	S 57°E	168·0	168·7	99·6	10	0·38
Burdwan . . .	29·513	29·612	+·135	S	S	S 30°E	107·5	80·9	133·0	10	1 04
Calcutta (Alipore) . .	29·614	29·636	+·169	SSW	S by W	S 27°E	221·0	121·7	181·6	10	0·08
Saugor Island . .	29·653	29·659	+·095	SSW	S	S 8°W	445·1	221·2	201·2	10	0·04
False Point . . .	29·658	29·673	+·054	SW	SSW	S 32°W	191·6	167·1	114·7	10	1·27
Cuttack	29·585	29·666	+·036	SW	S	S 7°W	50·0	61·2	81·6	7	0·52
Vizagapatam . . .	29·673	29·704	+·006	SW	SW	N 83°E	36·9	73·2	50·4	9	...
Masulipatam . . .	29·745	29·755	+·041	W	...	N 85°W	...	...	...	5	...
Madras	29·804	29·816	+·004	W by S	...	S 31°W	196·	189·	103·7	5	0·05

The barometric changes in the Bay and on the land area to the north, were almost wholly dependent on the movement of the cyclonic storm.

At considerable distances from it, as in the south and centre of the Bay and in Behar and Orissa, the barometer was slowly rising, the upward movement being apparently due to, and representing the phase of, the ordinary oscillatory movement in India. Immediately to the south of the vortex, in Southern and Central Bengal, the barometer was rising rapidly; the greatest rise, at this time, taking place at Burdwan, Calcutta and Jessore. On the other hand, in Northern Bengal and West Assam, the barometer was falling; but the slow rate of fall indicates that the vortex was already beginning to fill up. The centre, on the morning of the 23rd, was nearly mid-way between Purneah and Berhampore or, in the Bogra district. Six hours afterwards, at 4 P. M., the wind directions were much less regular, and show that the vortex was being rapidly broken up by the hills in Northern Bengal.

The air motion, as indicated by the returns of the Bay Islands, and of Diamond Island and the Coromandel stations, was now considerably feebler than it had been for some days. In the centre of the Bay, the wind velocity was probably only fifty or sixty per cent. of the usual strength. The moist atmospheric current, the feeder of the vortex, was now rapidly diminishing in strength; and, as the next day's observations show, the rainfall in Bengal, or the rainfall accompanying the cyclonic motion, was as rapidly diminishing in amount.

The general atmospheric motion in Bengal was, as hitherto, cyclonic. The most important feature is the contrast between the velocities in opposite quadrants. At sea,

the contrast had been between the southern quadrants and the northern quadrants. In Bengal the conditions of the cyclonic motion were evidently different from what they were at sea, and the contrast is indicated by the difference between the motion in the eastern and western quadrants. This is shewn by the following:—

Eastern quadrant.	Amount of wind in miles.	Western quadrant.	Amount of wind in miles.
Dacca	395·0	Burdwan	107·5
Goalpara	676·1	Purneah	172·0

and is exactly similar to the contrast between the amount of wind at Jessore registered on the 22nd, as compared with the amounts at Calcutta and Saugor Island.

The sky was overcast at all stations in Bengal, Assam, Behar and Arakan, and heavy rain fell over the whole of this area during the day. The rainfall was, however, excessive, only in Central and Northern Bengal.

The following table gives the average rainfall of the ten divisions of the Province of Bengal for the 24 hours preceding 6 P.M. of the 23rd:—

	Division.	No. of Stations.	Average rainfall of 24 hours preceding 6 P.M.
			Inches.
Bengal	Burdwan	18	1·04
	Presidency	29	1·78
	Rajshahye	17	3·45
	Cooch Behar	6	4·90
	Dacca	14	2·43
	Chittagong	12	1·43
Behar	Patna	24	0·39
	Bhagalpur	17	0·95
Orissa	Orissa	13	0·26
Chutia Nagpore	Chutia Nagpore	9	0·25

This rainfall is equivalent to an average of 1·6 inch over the whole Province, (including Bengal, Behar, Chutia Nagpore and Orissa). The rainfall was now diminishing in intensity, while, at the same time, the seat of concentrated rainfall had been transferred northwards and was spread over a wider area. The heaviest rain fell, on this day, in the Rajshahye and Cooch Behar Divisions.

The following gives rainfalls of five inches or upwards, registered in Bengal on the 23rd, and hence defines, more exactly, the limits of maximum precipitation at this period:—

Stations.	Rainfall of 24 hours preceding 6 P. M.	Stations.	Rainfall of 24 hours preceding 6 P. M.
	Inches.		Inches.
Bauleah	5·48	Titalya	7·23
Kurigram	11·44	Cooch Behar	8·85
Bogdogra	7·60	Mymensingh	6·20
Nowkhalli	6·20	Atia	8·05
Sherpore	8·35	Kishengunj	6·23
Boda	5·00		

The following heavy rainfalls were registered in Assam :—

	Inches.
Goalpara	5·89
Tura	9·33
Cherrapunjee	12·42
Jamui	9·80

Meteorology of the Bay of Bengal on the 23rd of September.—The following table gives the meteorological information contained in the logs of the various vessels for the 23rd of September :—

Name of Ship.	Latitude at noon.	Longitude at noon.	Winds.	Barometer, actual reading.	Barometer probable corrected reading.	Remarks on Weather.
Camona	8° 25′ N.	85° 56′ E.	4 A.M., W. S. W. Noon, W. S. W. (5). 4 P.M., W. (4)	29·79 29·74		
Loch Etive	19° 49′ N.	88° 25′ E.	1 A.M., S. S. W. 8 A.M., N. N. W. Noon, N. N. W. & variable. 4 P.M., S. E. Midnight, S.	29·64	29·72	1 A.M.—Strong breezes and cloudy. 8 A.M.—Wind shifted to the north-north-west with very heavy rain. Noon—Wind variable with very heavy rain. 3 P.M.—Calm with very heavy rain. 4 P.M.—Light wind and cloudy. Midnight—Light breezes and fine.
Fazel Kurreem	20° 20′ N.	88° 24′ E.	W. S. W.	29·68	29·63	Morning—Very strong winds in early morning from west-south-west; no stars visible; very strong rain. 6 to 8 A.M.—Squalls from the north-west with heavy rain. Rain continued the whole morning. 10 P.M. to midnight—Wind changed between south-west, south-west by west, and west-south-west.
First Lancashire	About 50 miles east-south-east of Eastern Channel Light-vessel.		W. S. W. to S.	29·45	29·60	Boisterous and unsettled weather during day with squalls and heavy rain. 8 P.M.—Weather clearing.
Phuttle Barry	20° 56′ N.	88° 10′ E., by account.	Morning, S. W. Evening, S.S.W.	... 29·18 (?)	... ...	Morning—Sounded and found ground at 16 fathoms; no sun visible; heavy clouds; drizzling rain and calm sea. 6 P.M.—Got a pilot; weather fine.
Madras	...	...	S. W. by S.	29·68	29·60	Early morning—Steady strong breeze with dry star-light weather. 2·30 A.M.—Passed the Mutlah L. V. 4 A.M. to 8 A.M.—Rain and thick weather, after which it cleared up and blew fresh all day.
Satara	Near the Sandheads		...	2 A.M., 29·34	29·64	2 A.M.—Heavy squalls of wind and rain from south-west. 8 A.M.—Wind blowing a fresh gale; high sea at the Sandheads with heavy rain at times.
Moulmein	...	...	... Evening, S. S. E. to E. S. E.	4 A.M. ... 29·50 ... Noon ... 29·57	... ...	Early morning—Hard gale and heavy squalls with rain. 5·30 A.M.—Gale moderating; heavy cross-sea running. 9·30 A.M.—Strong breezes; heavy sea with occasional showers. Noon—Elephant Point veering east by south, sounded in 14 fathoms; fresh breeze. Evening—Strong breezes with heavy rain.

Name of Ship.	Latitude at noon.	Longitude at noon.	Wind.	Barometer, actual reading.	Barometer probable corrected reading.	Remarks on Weather.
Meteor, L. V.	Intermediate Station in Gaspar Channel.		4 A.M., S. W.	29·60	29·44	4 A.M.—Dark and gloomy weather; heavy rain squalls.
			8 A.M., S. W.	29·80	29·64	8 A.M.—Moderate wind; overcast with continuous rain.
			Noon, S. W.	29·80	29·64	Noon—Fresh and overcast.
			8 P.M., S. by W.	29·80	29·64	8 P.M. to midnight—Moderate and cloudy.
Cassandra, P. V.	Proceeding up the River Hooghly.		4 A.M., S. W. 3.	29·74	29·56	
			Noon, S. W. 5.	29·80	29·62	
			2 P.M., S. 4	29·76	29·58	
			8 P.M., S. S. W. 3.	29·80	29·62	
Mermaid, L. V.	At Mutlah Station		..	...	...	2 to 8 A.M.—Strong breeze with heavy squalls of rain.
			4 A.M., S. W. by S.	29·61	29·51	8 A.M.—Strong breeze, rain and heavy sea.
			10 A.M., S. S. W.	29·72	29·62	10 A.M.—Fresh breeze, squally and heavy rain.
			Noon, S. S. W.	29·72	29·62	Noon—Moderate breeze and cloudy, heavy sea.
			2 P.M., S.	29·68	29·58	4 P.M.—Fresh breeze, dark and cloudy.
			8 P.M., S. W.	29·72	29·62	10 P.M.—Light breeze and cloudy.
Canopus L. V.	Eastern Channel Station		4 A.M., W.	29·72	29·57	2·30 A.M.—A hard westerly squall with thunder, lightning and heavy rain.
			8 A.M., S. W. by S.	29·75	29·60	8 A.M.—Moderate breeze; dirty-looking weather with rain.
			Noon, S.	29·80	29·65	Noon—Fresh breeze.
			4 P.M., S.	29·74	29·59	4 P.M.—Moderate breeze and cloudy weather.
			Midnight, W. S. W.	29·78	29·63	8 P.M. and midnight—Moderate breeze and fine, but cloudy.
Comet, L. V.	At Lower Gaspar Station		4 A.M., W. S. W.	...	...	2 A.M.—Strong breeze; heavy squalls with rain.
			8 A.M., W. S. W.	29·72	29·64	8 A.M.—More moderate weather; light overcast sky.
			Noon to 10 P.M., S. W.	4 P.M., 29·69	29·61	Noon—Strong breeze and overcast. 4 P.M.—Fresh breeze; clearing up.
			10 P.M., to midnight, S. S. W.	...	...	Evening—Light breeze and cloudy.
Foam, L. V.	At Upper Gaspar Station		4 A.M., S. S. W.	29·80	29·55	Midnight to 2 A.M.—Strong breeze; hard squalls with heavy passing showers.
			8 A.M., S. S. W.	29·90	29·65	2 A.M. to 6 A.M.—Strong breeze; passing squalls and showers.
			Noon, S.	29·87	29·62	6 A.M. to 11 A.M.—Fresh breeze; cloudy overcast sky.
			4 P.M., S.	29·82	29·57	11 A.M. to noon—Wind moderating; sky looking inclined to clear up.
			8 P.M., S. S. W.	29·88	29·63	Noon to 6 P.M.—Fresh breeze; squally appearance.
			Midnight, S. W.	29·90	29·65	6 P.M. to midnight—Light winds; finer looking sky; much lightning.

The logs of the vessels, for the 23rd, show that the weather continued to improve slowly in the Bay. The remarks in the preceding table indicate the general character of the weather fully. In the morning, the weather was unsettled, and occasional squalls occurred during the day. The following examples are deserving of special notice. The *Loch Etive*, in latitude 19° 49′ N. and longitude 88° 25′ E. at noon, had very heavy rain during the greater part of the day. The wind shifted from south-south-west to north-north-west, in a heavy squall, at 8 A.M. The wind was very variable at noon, and diminished in strength, until, at 3 P.M., calms and light winds were recorded. The *Fazel Kurreem*, about 30 miles to the north of the previous vessel, ex-

perienced similar weather. The winds from west-south-west, early in the morning, were very strong and accompanied with rain. Between 6 A.M. and noon, violent squalls from the north-west, with heavy rain, passed over the ship at intervals. The Captain of the steamer *First Lancashire* records, in his log, that the weather, on this day, was boisterous and unsettled, with frequent squalls and heavy rain, until the evening, when it began to clear up. The logs of the remaining vessels give similar accounts of the weather during the day. They indicate that it was unsettled and stormy; that heavy rain fell near the head of the Bay; and that squalls of wind and rain were of frequent occurrence. They also concur in stating that the weather moderated during the afternoon; and that, in the evening, after 6 P.M., light to moderate breezes with cloudy weather prevailed, and the sky had a finer and more settled appearance. The only important fact, that calls for special remark, is the occurrence of sudden, violent squalls from the north-west, on the 23rd, in the north of the Bay. They were experienced by the *Loch Etive* and *Fazel Kurreem*, and were similar in character to the north-west squalls that passed over the *Madras* and the *Satara* on the 22nd, when approaching the Hooghly. These squalls were apparently local disturbances, as they followed a sudden shift of wind from the south-west, and were probably not part of the general cyclonic circulation on the outskirts of the southern quadrant. The only explanations appear to be that, they were either the occasional prolongation of the north-west winds in the south-west quadrant, due to some temporary action—or, what appears to be much more probable, that they were due to local whirls or eddies set up in the rear of the advancing cyclonic vortex; probably accompanying and resulting from the heavy rainfall, which still continued near the head of the Bay.

To whatever they may have been due, they help to strengthen the conclusion which was drawn in former cyclone reports, that the atmospheric action, in larger cyclones, is much more complex and irregular than is usually assumed to be the case. The ordinary conception of a cyclone is that it combines a central area of comparative calm and of ascensional air motion, with a large outer area, in which the air is in a state of violent, but fairly regular convergence to the central area. If there be any general uniformity in the motion, it is much more probable that it is statistical or average uniformity, accompanying very considerable irregularity in detail, and not the absolute uniformity of approximately regular converging motion towards a well-defined centre.

Meteorology of the 24th of September (vide Chart VIII.)

Meteorology of India on the 24th of September.—The barometer rose considerably over the whole of India; except in the extreme south, as represented by the stations of Colombo and Cochin. The rise was greatest in Upper India, and exceeded one-tenth of an inch at the three stations of Kurrachee, Ajmere and Allahabad.

In Bengal, the atmospheric circulation was gradually returning to its normal character. Along the west coast of India, and in the peninsula, the winds were unchanged. In Upper India, westerly winds were recorded at the great majority of stations. This westerly atmospheric circulation obtained over the whole of the Gangetic valley above Benares; at Patna the wind was still east, and at Durbhanga east-south-east. The westerly current down the Gangetic valley, on this day, was evidently not the result of the cyclonic circulation in Bengal, for this was now almost broken up; but was, as the

meteorology of the remaining days of the month show, the commencement and establishment of the cold-weather winds down the Gangetic valley, which takes place at the termination of the rains in Upper India, and usually about the end of September. The westerly movement (*vide* chart of the 22nd) began, as usual, in the Panjab, and extended down the Gangetic valley.

Little or no rain fell in any province of India, except in Bengal and Assam. The weather was fine and sky clear over the Punjab, the North-Western Provinces, Behar, Rajputana, and the Central Provinces and Central India.

Meteorology of Bengal and the Coast Districts of the Bay of Bengal on the 24th of September.—The following table gives meteorological observations taken at stations in Bengal and the coast districts of the Bay, on the 24th of September:—

Stations.	Barometer, 10 A. M.	Barometer reduced to sea-level.	Change since previous day.	Wind Direction.		Mean direction of wind for September	Wind Velocity.			Amount of cloud, 10 A. M.	Rainfall.
				10 A. M.	4 P. M.		Number of miles previous 24 hours.	Average for past years.	Ratio of amount of wind to average amount expressed as a percentage.		
Nancowry	29·814	29·893	—·040	NW	SW	S 52° W	111·9	241·0	46·4	9	0·15
Port Blair	29·815	29·878	—·024	W	NE	S 40° W	145·0	235·6	61·5	6	0·11
Diamond Island	29·798	29·840	—·032	W	S	S 43° W	112·2	167·0	67·2	8	0·73
Akyab	29·801	29·822	+·009	SE	N by E	S 7° E	43·0	70·3	61·2	9	0·32
Chittagong	29·732	29·822	+·057	SE	ENE	S 27° E	147·6	109·2	135·2	10	2·39
Dacca	29·687	29·723	+·099	S	Calm	S 78° E	238·0	115·0	207·0	9	0·73
Jessore	29·697	29·731	+·109	W	WSW	S 23° E	55·0	79·0	69·6	10	1·33
Berhampore	29·654	29·755	+·136	NNW	NNW	S 45° E	120·4	86·4	139·4	10	0·06
Silchar	29·702	29·790	+·029	ENE	Calm	S 49° W	44·1	64·9	68·0	9	0·59
Goalpara	29·354	29·744	+·103	ENE	Calm	S 68° E	537·3	90·8	591·7	10	5·65
Sibsagar	29·475	29·809	+·042	N	ENE	N 62° E	60·7	61·8	98·2	10	0·40
Purneah	29·580	29·707	+·050	NE	...	S 79° E	88·0	63·0	139·7	10	0·19
Durbhanga	29·519	29·687	+·084	ESE	E	S 87° E	85·9	91·8	93·6	9	...
Patna	29·495	29·673	+·067	E	E	S 84° E	24·2	62·5	38·7	8	...
Gya	29·301	29·677	+·072	Calm	Calm	S 78° E	50·0	54·8	91·2	2	0·37
Hazaribagh	27·701	29·684	+·083	W	WNW	S 57° E	169·5	168·7	100·5	3	...
Burdwan	29·619	29·720	+·106	Calm	S	S 30° E	20·7	80·9	25·5	10	0·21
Calcutta (Alipore)	29·699	29·719	+·083	NW by N	ENE	S 27° E	103·0	121·7	84·6	10	0·04
Saugor Island	29·708	29·714	+·055	SW	NE	S 8° W	241·6	221·2	109 2	10	0·07
False Point	29·692	29·707	+·034	W	ENE	S 32° W	111·5	167·1	66·7	9	0·34
Cuttack	29·624	29·705	+·039	W	Calm	S 7° W	35·1	61·2	57·3	4	...
Vizagapatam	29·699	29·730	+·026	NW	SE by S	N 83° E	35·5	56·3	63·1	4	...
Masulipatam	29·765	29·775	+·020	W	...	N 85° W	...	...	...	4	...
Madras	29·821	29·843	+·017	W	...	S 31° W	165·	157·9	104·5	6	...

The preceding observations show that, excepting at Nancowry, Port Blair and Diamond Island, the barometer was generally rising. The rise was small in amount at

the most southerly stations, but was rapid in Central and Northern Bengal, where the pressure increased quickly with the disappearance of the cyclonic vortex.

The rise of the barometer, it may be noted, was coincident with a general diminution in the strength of the lower monsoon current. The wind velocity of the 24 hours, preceding 10 A. M. of the 24th, was above the average at Chittagong, Dacca, Berhampore, Goalpara, Purneah, and Saugor Island. At the majority of the remaining stations, it was considerably below the average, and the winds were again "light and variable" as they had been before the formation of the cyclonic vortex. This was very conspicuously the case at Goalpara. At that station, the amount of wind registered, at 10 A. M., was nearly six times the daily average wind velocity for September. So rapidly did the winds diminish in strength with the disintegration of the vortex, that at 4 P. M. of the same day "calms" were recorded.

The area of least relative air motion, as shewn by the returns, was now in the east of the Bay. The winds at Nancowry, Port Blair, Diamond Island and Akyab were only from fifty to seventy per cent. of their average force. They were moreover very variable. Thus, at Port Blair, the wind at 10 A. M. was from west, and at 4 P. M. from north-east; at Nancowry, it was from north-west at 10 A. M., and south-west at 4 P. M.; and at Diamond Island, it was west at 10 A. M., and south at 4 P. M. Hence, probably, over the centre, and certainly over the south-east and east of the Bay, the winds were now light and variable. Further north, at the head of the Bay, the winds were from the normal direction (south to south-west) and were of average strength. The *Loch Etive* described the weather, in the early morning, as "cloudy with moderate breezes."

In Bengal and Behar, the winds were rapidly diminishing in strength, but were generally south in Bengal and east in Behar, indicating that ordinary monsoon winds (accompanied with moderate rain) were blowing over the whole of this area.

The sky was still overcast at the majority of the Bengal stations. In Chutia Nagpore, and Southern Bengal, and at the more southerly Bay stations, the sky was only slightly clouded, and the weather fine but somewhat sultry.

Rain fell over the whole of Bengal and Assam during the 24 hours preceding 6 P. M. It was heaviest in Northern Bengal and Assam, and small in amount in the Orissa, Chutia Nagpore, and Patna divisions. The amount and distribution of the rainfall is given in the following table:—

Divisions.	Number of Stations.	Average rainfall of preceding 24 hours.
		Inches.
Burdwan	18	0·35
Presidency	29	0·78
Rajshahye	17	1·21
Cooch Behar	6	5·35
Dacca	14	1·54
Chittagong	12	1·13
Patna	24	0·10
Bhagalpur	17	0·54
Orissa	13	0·12
Chutia Nagpore	9	0·03

or an average of ·85 inch for the whole province.

The only rainfalls, for this day, exceeding 5 inches, at stations in Bengal, are the following:—

	Inches.
Julpigoree	7·13
Boda	7·00
Cooch Behar	8·43

In Assam, rainfalls exceeding 5 inches were registered at the following stations:—

	Inches.
Goalpara	5·65
Dhubri	10·50
Tura on the 24th	7·29
„ on the 25th	9·10
Cherra Punjee	5·90

The cyclonic vortex completely disappeared on the 24th. The winds, on the morning of that day, indicated a feeble cyclonic circulation in Northern Bengal. On the 25th, ordinary monsoon winds, considerably below their average strength, obtained. The weather was generally fine, with occasional showers.

The logs of the vessels, with one exception, terminate with the observations of the 23rd of September. The log of this single vessel shews what the evening observations of the previous day (the 23rd) on board the other vessels indicate, that the weather was now fine over the Bay, the sky clear or slightly clouded, the winds normal in direction, but below their monsoon strength, and the sea much less disturbed in the centre and South of the Bay, and smooth in the North of the Bay. Hence the stormy weather associated with this cyclonic vortex terminated in the Bay on the 23rd, and over the land area (*i. e.*, in Bengal) on the 24th.

DISCUSSION OF THE MORE IMPORTANT PHENOMENA OF THE SOUTH-WEST MONSOON STORM OF THE 17TH TO 24TH SEPTEMBER 1878.

The preceding history of the formation and advance of the cyclonic storm of the 19th to 24th September 1878, in the Bay of Bengal and in Bengal, furnishes a number of inferences with respect to cyclonic generation and motion in the Bay of Bengal, nearly all of which appear to confirm the results given in the Backergunge and Madras cyclone reports.

General characteristics of South-West monsoon storms.—The cyclonic storms of the rainy season in the Bay of Bengal are intermediate, in magnitude and intensity, between the fierce and extensive cyclones of the transition periods, introductory to, and following, the South-West monsoon or rainy season in India, and the small local storms known as dust-storms, tornadoes, nor'-westers, &c., common to all tropical countries, where considerable heating effects occasionally accumulate, and give rise to great local atmospheric disturbance. These minor cyclones have the characteristic features of an area of barometric depression, and occasionally, perhaps, a calm centre or limited area of upward air motion. The winds are generally violent, and present the spiral or incurving motion, now known to be that which occurs in all cyclonic storms. They are often trying and dangerous to shipping, on account of the heavy

cross sea and the rapid changes of wind which occur, and are due to the limited area over which the storm extends. The barometer rarely falls below 29·2″, and as the normal average height at the head of the Bay during the rains varies from 29·5″ to 29·6″, the fall of the barometer due to these cyclonic storms, seldom, if ever, exceeds half an inch. They are, moreover, never accompanied by an appreciable storm wave. The fall of the barometer is usually too small, the area of the storm region too limited, and the duration of the storm too short, to produce the large accumulation of water over the central area of the cyclone, which constitutes a storm wave.

Antecedent atmospheric conditions of the storm of the 17th to 24th September.—The area, visited and affected by the storm of the 17th to the 24th September, was the Northern half of the Bay, Bengal, Arakan, Orissa, Assam, and Eastern Behar. Beyond this area, the atmospheric circulation was unaffected in direction; and, except in the North-Western Provinces, was probably little, if at all, altered in amount. A previously-formed cyclonic vortex, in Western India, slowly broke up on the 17th, 18th and 19th of September, uninfluenced by the formation of the vortex in the Bay. The winds over the greater portion of Northern India, including the North-Western Provinces, the Punjab, Rajputana, &c., were normal in direction, during the whole period of the formation of the cyclonic vortex. The usual change of the wind directions, introductory to the commencement of the cold weather, and which usually takes place in the third or fourth week of September, commenced, in the Punjab, during the prevalence of the storm, and gradually extended eastwards. The wind velocity, in Northern India, was small in amount and considerably below the average; but this meteorological feature was not a consequence of the formation and extension of the vortex, but an antecedent and independent meteorological condition over the whole of Northern India; and one which always obtains at the end of September, when the winds revert to their cold weather direction. It was, however, most marked near the head of the Bay and in Eastern Bengal.

Hence, so far as can be judged from the conditions, the cyclonic storm originated in and moved over a well-marked area, and its origin, existence and motion, were due solely and entirely to certain antecedent and concurrent atmospheric conditions over the area which the storm visited; and were not due, primarily or mainly, to atmospheric conditions, beyond the area of the cyclonic disturbance. The whole history of the cyclone appears to establish this. The strongest proofs are those already given, *viz.*, that the previously-formed cyclone maintained its existence independently of the other and that the transition from the rains to the cold weather set in normally over the Punjab, and extended eastwards during the prevalence of the storm in Bengal. The conclusion, if justified by the evidence, seems to be an important one, that the origin of the cyclonic storm was due to a certain assemblage of abnormal atmospheric conditions, established in and prevalent over the storm area itself.

Immediately prior to the origin of the cyclone, the whole of the area over which this storm extended *viz.*, the North of the Bay, Arakan, Bengal, Assam, Orissa and Chutia Nagpore, was an area of decreasing differences of pressure and of diminishing air motion. The charts of the 17th, 18th and 19th show, as strikingly as it is possible to exhibit such phenomena, the prevalence of approximate uniformity of pressure over the storm area in Bengal and at the head of the Bay, antecedently to the arrival of the

storm, and they also indicate that the differences of pressure diminished steadily over the area until the morning of the 19th; by which time the cyclonic vortex and storm were well developed in the Bay. The small barometric differences over the head of the Bay and adjacent land area accompanied, as is usually, though not always, the case, the prevalence of light, and in part of the area, variable winds. The winds in Arakan and Bengal, as has been shown, averaged only from 20 to 60 per cent. of their normal strength in September, during the origin and development of the storm. The logs of the light vessels, and the ships near the head of the Bay also indicate, as clearly as the land observations, that the air motion in the Northern portion of the Bay presented the same characteristics as in Bengal. They all concur in describing the winds as "light and variable airs and calms." It has also been shown that the cyclone crossed through that portion of Bengal where the air motion was relatively least, immediately prior to the arrival of the cyclone. Hence it is certain that the characteristic antecedent atmospheric conditions over the greater part and, therefore, probably, over the whole of the area affected by the small cyclone, were "almost absolute uniformity of pressure accompanying the prevalence of light (and over a considerable portion of the area) variable winds and calms". It may also be fairly assumed that, these characteristics were as fully developed over the sea area affected as over the land area, and that the storm originated over the former area, when the further condition of heavy concentrated rainfall was added to the conditions previously existing.

Beyond and to the South of this area of light and variable airs and calms and of approximately uniform pressure, the air motion was the same in direction as usually obtains during the South-West monsoon. Over the centre and South of the Bay, the ordinary South-West monsoon winds prevailed. Judging from the anemometric returns of the Ceylon stations and of Madras and the South Indian stations, and also of the logs of the vessels in the South of the Bay, the monsoon winds were above their normal strength at this time.

To the North and West—in Behar, the North-Western Provinces and the Punjab—the winds, during the whole period of the formation of the cyclonic vortex, were easterly; and indicated the continuance or rather the gradual decadence of the monsoon current, or of the ordinary atmospheric advance up the Gangetic valley from the Bay of Bengal, which forms a more or less persistent feature during the South-West monsoon. The gradual retreat of the easterly monsoon winds down the Gangetic valley during the last fortnight of September, and the persistence of strongish monsoon winds in the South of the Bay during the whole month, are normal features of the meteorology of September.

Hence the conclusion is almost irresistible that, while abnormal atmospheric conditions prevailed over the area in which the cyclone was generated, and over which it extended, the atmospheric conditions were approximately normal over considerable areas immediately to the South, West and North, and probably also to the East in Central and Northern Burmah. Hence, again, an additional reason for the conclusion, that this cyclonic disturbance was primarily due to special and abnormal atmospheric actions, resulting from abnormal atmospheric conditions in and over the area of disturbance itself.

Initial actions determining the cyclonic movement.—The antecedent favourable conditions were almost certainly followed by or accompanied with peculiar atmospheric

actions or motion which have been already indicated, and which are sufficient to account for the initiation, formation and development of the cyclonic motion. The strong South-westerly winds, over the South and centre of the Bay, indicated a rapid transfer of air, horizontally, from South to North, over a considerable portion of the Bay. To the North of this area of rapid horizontal transfer, the horizontal air motion was almost *nil*. Hence, the only supposition, which the condition of continuity of the atmospheric mass allows, is that the horizontal air motion was converted partly, if not entirely, into vertical air motion, over the southern limits of the area of light variable airs and calms, near the head of the Bay. The atmospheric conditions thus seem to indicate plainly, the commencement and continuation of abnormal ascensional air motion, on a large scale, over the southern portion at least of the area of light airs and calms. It was apparently over this area, that heavy rain, more or less general in character, fell on the 17th and 18th. And concurrently with the continuation of the rainfall, the area became one of diminishing pressure, of increasing winds, and of cyclonic air motion. The logs of the vessels indicate this fact very clearly. The charts of the 17th and 18th, in which this information is tabulated, also present the facts with sufficient precision, to render the statement not merely probable, but almost as certain as any physical inference from limited observation on the large scale can be. Hence, the atmospheric action, consequent on the initial favouring atmospheric conditions, (stated in page 54) which determined the origin and growth of this area of cyclonic air motion, was the vertical ascending motion of a moist current, over a small but well-defined area; followed, almost immediately, by heavy and continuous rainfall, which was limited, for a considerable period to this area.

Relation of wind distribution to the path of the cyclone.—It has been already proved that, immediately previously to the formation and advance of the cyclone, the whole storm area was one in which light and variable airs and calms prevailed. The unsteady character of the winds and the frequent changes of wind direction have also been fully pointed out in the meteorology of Bengal for the 18th, 19th and 20th.

The antecedent period of light and variable winds in Bengal lasted until the morning of the 20th in Southern Bengal, and the morning of the 21st in Northern Bengal. The following table gives, in a brief form the chief facts of observation of the velocity of air motion in Bengal, &c., before and during the storm. The first column for each day gives the number of miles of wind registered for the 24 hours preceding 4 P.M. of that day; and the second column for each day gives the ratio, expressed as a percentage of the actual air motion, in miles of wind recorded by the anemometer on any day, to the normal or average daily air motion in September at the same station:—

STATIONS.	17TH.		18TH.		19TH.		20TH.		21ST.	
	Amount of wind in day.	Ratio to average amount of wind or wind per-centage.	Amount of wind in day.	Ratio to average amount of wind or wind per-centage.	Amount of wind in day.	Ratio to average amount of wind or wind per-centage.	Amount of wind in day.	Ratio to average amount of wind or wind per-centage.	Amount of wind in day.	Ratio to average amount of wind or wind per-centage.
Akyab	62·0	73·9	50·0	71·0	44·0	62·6	54·0	76·8	17·8	25·3
Chittagong	50·2	46·0	30·8	28·2	29·8	27·3	38·7	35·4	13·3	12·2
Dacca	85·0	73·9	17·0	14·8	25·0	4·7	24·0	20·9	54·0	46·9
Jessore	63·6	80·5	56·5	70·3	23·3	29·0	18·4	23·3	16·0	20·3

STATIONS.	17TH.		18TH.		19TH.		20TH.		21ST.	
	Amount of wind in day.	Ratio to average amount of wind or wind percentage.	Amount of wind in day.	Ratio to average amount of wind or wind percentage.	Amount of wind in day.	Ratio to average amount of wind or wind percentage.	Amount of wind in day.	Ratio to average amount of wind or wind percentage.	Amount of wind in day.	Ratio to average amount of wind or wind percentage.
Berhampore	83·5	96·6	56·1	64·9	37·4	43·4	36·1	42·0	44·5	51·6
Silchar	31·9	49·2	44·7	68·9	36·3	56·0	58·6	90·0	76·2	117·4
Goalpara	39·7	43·7	57·0	62·8	80·9	89·0	115·9	128·0	91·0	100·0
Purneah	78·0	123 8	15·0	23·8	45·0	71·0	28·0	44·4	54·0	85·7
Durbhanga	111·7	12·7	80·2	87·4	37·1	40·4	42·9	46·8	47·5	51·7
Gya	60·0	109·5	40·5	73·9	24·5	45·0	20·0	36·0	30·0	54·7
Hazaribagh	230·9	136·9	197·6	117·1	133·0	78·9	91·5	54·0	85·7	50·0
Burdwan	81·5	100·7	47·5	58·7	27·5	34·0	86 0	43·0	64·3	79·0
Calcutta	111·0	92·2	70·0	87·5	63·0	52·0	73·0	60·0	110·0	90·0
Saugor Island	189·7	85·7	118·9	53·7	131·0	59·0	105·0	47·6	20·7	94·0
False Point	124·6	74·6	94·5	56·6	104·0	62·0	85·6	57·3	145·8	87·3
Vizagapatam	73·2	130·0	57·5	102·0	42·7	76·0	30·0	53·2	8·7	15·4
Madras	189·0	120·0	194·0	122·9	218·0	144·0	23·8	151·0	234·0	148·0
Port Blair	443·0	186·7	536·1	225·9	545·2	229·8	456·7	192·5	393·0	165·6
Nancowry	312·3	131·4	435·8	183·4	452·3	190·4	402·4	169·4	380·3	160·1

The ratios or percentages given in the preceding table cannot be considered as more than approximately exact. The anemometer is by no means a satisfactory instrument, more especially at the majority of mofussil stations in India. The instrument, in order that it may give comparable readings for the whole period of its employment, should be kept perfectly clean and be frequently oiled. In a climate like that of India, where a long period of dry, hot and dusty weather is succeeded by a equally lengthy period of excessive moisture, these precautions are even more necessary than in European countries; but unfortunately the native observers in India too frequently neglect this instrument. A small alteration in the amount of friction or a slight flexure of any part is sufficient to alter very considerably the relation between the velocity of the rotation of the cups and the wind velocity. It is hence not desirable, as a rule, to base any conclusion upon the evidence of a single anemometer, or set of anemometric readings of a single instrument. In the following remarks, the inferences are, in every case, derived from observations at two or more neighbouring, stations, which show a sufficiently close agreement, to warrant the assumption that they are approximately correct; and that they, therefore, give a fairly accurate view of the lower air motion over the air represented meteorologically by these stations. I may add that, when I inspected the Patna Observatory, in November 1880, I found the anemometer badly placed and badly mounted, and its teeth much worn, and hence the readings for the previous 18 or 24 months are by no means trustworthy. Hence, no conclusion can be based on the very low velocities of the wind, recorded at Patna, during the storm in September 1878.

The table of wind velocities presents several uniformities of considerable importance, each based on the evidence and observations of two or more stations, and which may

therefore be fairly assumed to represent abnormal conditions of air motion at this period; of the existence of which there can be no doubt. These are as follows:—

1st.—For several days prior to the 21st of September, the air motion over the whole of Bengal, Assam and Orissa, was very considerably below the September average. The average for each of these districts, for the period September 17th to 21st, is—

Provinces.	Daily average of September 17th to 21st, 1878.	Normal daily average.
Bengal	60·1	96·6
Assam	57·5	72·7
Orissa	71·9	117·9

2nd.—During the same period, the air motion along the West Coast of the Bay, as far North probably as Vizagapatam, was above the average. The air motion was relatively greatest along the Coromandel Coast. The evidence for this is based on the observations taken at Madras and Vizagapatam; but as both observatories have a very high character for the accuracy of their observations, the results may not only be unhesitatingly accepted for those stations, but may be assumed to represent those of the whole of the West coast.

3rd.—Similarly, along the British Burma coast, (as represented by Diamond Island and Akyab) and at the Bay Islands, the air motion during this period and antecedently to it, differed very slightly, in direction, from the average September air motion, and was considerably in excess.

Hence the air motion was therefore either almost normal, or slightly in excess, over both the East and West coasts of the Bay.

4th.—Over the coasts of Bengal and Orissa, as represented by Chittagong, Saugor Island and False Point, the air motion was very considerably in defect. At Chittagong, it averaged, during this antecedent period, (*viz.*, from the 17th to the 21st), only 29 per cent. of its usual amount; at Saugor Island it averaged nearly 68 per cent.; while, at False Point, it averaged 66 per cent. These results plainly indicate that the air motion, along the North-West angle of the Bay, was below the average, but to a very much less extent than in the North-East angle of the Bay; and by an amount, which is not unusual in the latter half of the month of September, when the monsoon usually diminishes in strength. The air motion at Chittagong was extremely small, compared even with that at False Point and Saugor Island. Assuming these results to be correct, (and they are confirmed by the Dacca and Jessore wind observations), the air motion, in the North-East angle of the Bay, was less than 30 per cent. of its normal amount in September.

Hence the anemometric observations indicate, with sufficient clearness, that the North-East angle of the Bay was, at this time, not only an area of light winds, but also an area of minimum relative air motion, or of greatest variation from the normal air motion at this period.

5th.—The observations, taken at the observatories in the interior of Bengal, show that the same marked difference in the character of the air motion, relatively to the normal state, existed in Bengal, as along the coast. Just as the West coast of Bengal

had relatively a much higher air motion than the East coast, so, in West Bengal, the air motion was very considerably greater than in Central and East Bengal.

The following averages indicate the contrast:—

	Stations.	Wind percentage for September, 17th to 21st.	Wind percentage for September, 19th to 21st.
West Bengal	Calcutta	70·0	67·0
	Burdwan	63·0	52·0
	Berhampore	60·0	45·0
Central Bengal	Jessore	43·5	22 3
Eastern Bengal	Dacca	35·6	29·8

Hence it follows that, in Eastern and Central Bengal, the air velocity was very considerably below the average; and that this was the inland continuation of the similar conditions, existing over a small portion of the North-East coast, as indicated by the anemometric observations of Chittagong. Jessore, more especially, presented the feature of a steady continuous decrease of wind velocity during this antecedent period. Hence, it may be fairly assumed that, the air motion was a minimum at Chittagong, and at the Bengal stations of Jessore and Dacca; and probably over the whole area represented by these stations.

The distance between Saugor Island and Chittagong is upwards of 150 miles, and it is by no means improbable that the air motion on the coast South of Jessore was much smaller than at Saugor Island, and it may even have been as low as at Jessore or even at Chittagong. This, however, is, at the utmost, a probable conjecture.

The great majority of the minor cyclones of the South-West monsoon cross the Bengal coast to the West of Saugor Island, as might be inferred from the list of storms given in pages 3 to 6. The vortex, in this case, crossed to the East of Saugor Island and advanced northwards past Jessore, and a few miles to the west of that station, or over that part of Bengal which was characterized by minim um air motion previously to the advent of the cyclone. Hence, the only conclusions which can be derived from the observations are that, the cyclone was generated in an area of minimum air motion or of "light variable winds and calms"; that it advanced towards a part of the coast, such, that one of the two nearest observing stations presented the similar feature of minimum air motion; and through that part of Central Bengal, in which, as indicated by the observations at Jessore, the relative air motion was also a minimum.

Hence the general inference that, the vortex of this small cyclone advanced, during its existence, in a direction which coincided approximately with the line of least relative air motion, immediately antecedent to the cyclone.

Relation of rainfall distribution to the path of the cyclone.—The cyclonic vortex, formed on the 17th and 18th, advanced, in an almost due northerly direction, across the coast of Bengal, about 30 miles East of Saugor Island, and continued to move in the same general direction, parallel to the Hooghly, curving slightly towards the East,

during the 22nd and 23rd; and broke up on the morning of the 24th, probably in the Bograh or Rungpore district of Northern Bengal. One important feature, in connection with it, was the very large amount of rain that fell, during its existence, in the North of the Bay, and over the whole of Bengal. In none of the ships or light vessels, were any measurements of rainfall taken. The remarks given in the log books, however, indicate that it was extremely heavy and continuous. Among the more striking brief sailor's descriptions of it are the following:—"Very heavy rain;" "thick heavy rain" "torrents of rain;" "torrential rain;" "a deluge of rain." The remarks in the log books also show, with equal clearness and precision, that the rainfall was not in the form of occasional showers, but was of that continuous and persistent character which is associated with prolonged stormy weather in the Bay of Bengal. The rainfall at sea was, therefore, of the usual intense concentrated and torrential kind, over a well defined and limited area, which invariably accompanies the formation and existence of cyclonic storms in the Bay of Bengal.

The prolonged existence of the cyclone in Bengal, for three days, affords ample material for estimating the amount, distribution and character of the rainfall over the land area during the storm.

The complete rainfall return of the Province of Bengal, for the month of September, is given in an appendix, for the sake of reference. It shows that rain fell, to a greater or less extent, over the whole area of cyclonic circulation. The rainfall was, however, small in amount, in the districts of Behar, Chutia Nagpore and Orissa, which were only partially included within the storm area.

The following table gives the average amount of rainfall in the various divisions of Bengal, (excepting the Provinces of Behar, Orissa and Chutia Nagpore), for each of the three days of the storm—September 22nd, 23rd and 24th. As already stated, the results are for the 24 hours preceding 6 P.M. of the day in question:—

Divisions.	Number of Stations.	September 22nd.	September 23rd.	September 24th.	Total.
Burdwan	18	5·78	1·04	0·33	7·15
Presidency	29	2·90	1·78	0·78	5·46
Rajshahye	17	1·13	3·45	1·21	5·79
Cooch Behar	6	0·83	4·90	5·35	11·08
Dacca	14	0 76	2 43	1·54	4·73
Chittagong	12	2·03	1·43	1·13	4·59
Average for Bengal . .	...	2·24	2·51	1·72	6·47

The average rainfall over Bengal, (including an area of 90,000 square miles,) during the interval that elapsed between the passage of the vortex across the Bengal coast, on the evening of the 21st, and its disintegration on the 24th, was consequently, very nearly, six and a half inches. This is equivalent to 38,000,000,000 tons of water withdrawn from the atmosphere and discharged upon the land. As this excludes the rain which fell in connection with it in Burma, Arakan, Western Assam, Behar and Chutia Nagpore, it is probable that the rainfall over the land exceeded 50,000,000,000 of tons, and that as

the rainfall over the sea was as heavy as over the land, the total amount exceeded 100,000,000,000 tons.

Rain, during this period, was confined, almost entirely, to Bengal and the districts bordering on it. The following table gives the average rainfall during the same interval in the other large divisions of the Empire :—

Province.	Number of Stations.	Average Rainfall.		
		September 22nd.	September 23rd.	September 24th.
North-Western Provinces and Oudh . . .	169	0·12	0·17	0·02
Punjab	32	0·24	...	...
Bombay	15	0·58	0·15	0·08
Madras	13	0·18	0·11	0·09

The very slight rainfall in these four divisions of the Empire, averaging only a few hundreths of an inch, and due to occasional local showers, falling over very limited areas, stands in complete contrast with the concentrated and protracted rainfall in Bengal.

Hence, the rainfall over the land area, visited by the cyclone, was unusually heavy and continuous over a well-defined area; and beyond this area, it was almost *nil* in amount. The rainfall, over the storm area in the Bay, was certainly as intense and persistent, lasting as long, *viz.*, from the 17th to the 21st or 22nd; and it is probable from the expressions used to describe it, that it was as large, at least, if not considerably greater in amount, than in Bengal.

One other important feature of the rainfall in Bengal, during the cyclone, was the irregularity of its distribution. The rainfall chart (plate IX) gives the most important facts. In it, the total rainfall, at each station, is marked in figures at the position of the station. The general character of the distribution is indicated by the isohyetic lines, or lines of equal rainfall, for amounts of 5, 10 and 15 inches. The following are some of the chief features in the general distribution of the rainfall, and are clearly indicated by the chart:—

1st.—The heaviest rainfalls (*i. e.*, total rainfall exceeding 10 inches) occurred over small and somewhat irregular oval-shaped areas. There are three such small areas in which the rainfall exceeded ten inches. One of these is on the West of the line of advance of the vortex; a second is to the East; and the third in the continuation of the line of advance of the vortex in Northern Bengal. Whence it is evident that, the line of advance of the vortex did not coincide, in direction, with the line or belt of maximum total rainfall.

2nd.—In the same chart, the positions of the stations, at which rainfalls exceeding five inches in 24 hours during the cyclone, are marked by a bar underneath the total rainfall, and by two bars if the rainfalls on each of two days exceeded five inches. A reference to the chart will show that, these stations of probably most rapid or intense rainfall are as irregularly distributed as the districts of maximum rainfall. They do not suggest a connected or continuous line of maximum rainfall, coincident with the path of the cyclone.

Hence, there appears to be no simple and direct connection between the path of the cyclonic vortex and the area of maximum, or of most intense and rapid rainfall, during the cyclone. The line of advance may perhaps be regarded as approximately representing the mean direction, about which a large assemblage of irregular actions, accompanying irregular rain precipitation, were taking place.

3rd.—A third important point is the great irregularity in the distribution of the rainfall. Stations at very small distances from each other received widely differing amounts. It will be sufficient to give two or three typical examples :—

Divisions.	District.	Station.	Rainfall.		
			September 22nd.	September 23rd.	September 24th.
Burdwan	Midnapore.	Ghatal	11·08	0·59	0·53
		Midnapore.	2·70	0·16	0·34
Presidency.	24-Pergunnahs	Baraset	12·32	0·12	0·63
		Barrackpore	14·87	...	1·00
		Diamond Harbour	2·50	0·14	0·02
		Satkhira	0·95	0·60	1·50
	Nuddea	Kooshtea	2·12	4·68	1·65
		Kishnaghur	2·38	1·05	0·41
	Jessore	Jhenidah	2·15	2·42	2·37
		Bagirhat	...	0·60	1·00
	Moorshedabad	Berhampore	1·88	4·59	0·66
		Rampore Haut	0·90	0·78	...

A reference to the table of rainfall in Bengal, during the month of September 1878, will show this more fully.

The same feature is also indicated by the general character of the distribution, as shown by the chart. Along the seaboard of the Sunderbunds, the total rainfall, during the cyclone, was comparatively small. The rainfall increased rapidly northwards, but, in Southern Bengal, was very distinctly heaviest to the West of the path of the vortex; a limited area, including Serampore, Hooghly, Jehanabad and Ghatal, receiving an amount exceeding ten inches. In Central Bengal, the rainfall was as distinctly largest to the East of the line of advance, and excessive rainfalls (exceeding 10 inches) occurred in an area including Mymensingh and Atia. The centre probably broke up in Central Bengal, but the heavy rainfall, at the foot of the hills in Cooch Behar and Julpigori, was clearly due to the cyclone. Hence, it is evident that, the rainfall was, in every respect, very irregular in its distribution; great variations and differences in amount occurring at places within a few miles of each other; and also that there is no well-defined relation between the distribution of the rainfall and the line of advance of the cyclonic vortex.

The most remarkable fact, illustrating its irregularity, is the extremely small amount along the Bengal coast, where it probably did not exceed 1 or 2 inches.

The utmost that can with certainty be inferred is that, rainfall formed an important and essential feature in the phenomena of this small cyclone, but that, both in amount and distribution, it was subject to great local irregularities. It was, however, generally excessive over the greater part of the area affected by the storm, and the area of heavy rainfall was almost coincident in extent with the area of barometric depression and of violent atmospheric motion.

TABLE OF RAINFALL RECORDED AT STATIONS IN

Divisions.	Districts.	Stations.	1	2	3	4	5	6	7	8	9	10	11
BENGAL.	*Western Districts.*												
BURDWAN	Burdwan	Burdwan	...	0·10	0·70	0·21	0·03	0·05	0·01	0·02	...	...	0·38
		Cutwa	1·30	2·08	1·17	0·04	0·86	...	...	...	...	...	1·58
		Culna	...	...	...	1·84	0·82	...	...	...	...	...	...
		Bood-Bood	...	...	0·50	0·26	0·10	0·17	...	...	...	...	0·25
		Raneegunge	0·19	0·49	...	0·70	0·05	0·03	...	...	...	0·05	...
		Jehanabad	...	...	...	2·57	...	0·19	...	...	...	...	...
	Bankoora	Bankoora	0·15	...	0·10	1·30	...	...	...	...	...	...	1·36
	Beerbhoom	Soory	0·27	0·26	...	2·83	0·05	...	0·05	...	...	0·95	0·06
		Hetampore	1·40	0·36	0·02	2·07	0·05	0·36	1·11	...	...	0·60	...
		Roypore	0·42	0·68	0·05	0·27	0·14	0·62	0·12	...	...	...	0·12
	Midnapore	Midnapore	...	...	...	1·21	1·16	0·38	...	...	...	...	...
		Tumlook	...	...	...	2·30	0·60	...	...	...	...	...	...
		Ghatal	...	...	0·07	1·42	1·32	0·03	...	0·44	...	...	0·15
		Contai	...	...	...	1·77	...	...	...	...	...	...	...
	Hooghly	Hooghly	...	...	1·20	0·52	1·28	0·13	0·07	...	...	0·01	0·27
		Serampore	...	...	0·30	0·64	0·46	0·14	...	...	0·05	0·02	...
	Howrah	Howrah	...	...	0·45	0·15	0·10	0·80	...	...	...	...	0·03
		Mohesrakha	...	...	0·15	0·75	0·66	0·13	...	...	...	0·44	...
PRESIDENCY	24-Pergunnahs	Saugor Island	0·02	...	...	3·24	0·10	0·44	...	...	0·19	...	...
		Calcutta	...	...	0·20	0·55	0·25	0·55	...	...	...	...	...
		Alipore	0·01	...	0·19	0·60	0·27	0·46	0·11	...	...	...	...
		Busseerhat	...	...	0·60	0·13	0·03	...	0·07	0·84	0·12	...	...
		Baraset	...	...	0·31	0·28	0·69	0·25	0·24	...	...	...	...
		Diamond Harbour	...	...	...	1·57	1·98	0·16	...	...	...	0·20	3·00
		Barripore	...	...	0·03	0·61	0·26	...	0·18	0·02	0·15	...	...
		Satkhira	0·10	0·20	2·00	0·06	...	0·60	0·40	...	0·70	0·10	0·03
		Barrackpore	...	...	0·28	0·49	0·39	0·05	...	...	0·24	...	...
		Dum-Dum	...	...	0·26	0·40	1·65	1·20	0·24	...	...	...	0·10
	Nuddea	Kishnaghur	...	...	1·53	0·35	0·34	...	...	...	...	...	0·40
		Bongong	...	2·15	0·26	1·56	...	0·43	...	...	...	...	...
		Meherpore	...	0·40	1·31	...	...	...	...	...	...	...	0·80
		Chooadangah	1·13	...	2·50	0·57	...	...	...	...	0·06	0·50	0·10
		Kooshtea	0·20	0·07	...	...	...	...	0·12	...	...	...	1·14
		Ranaghat	...	0·60	0·80	1·30	0·74	...	...	...	...	...	...
	Jessore	Jessore	0·06	...	0·12	0·28	...	0·09	...	...	...	...	...
		Narail	...	0·03	0·85	0·23	...	...	...	...	...	0·03	...
		Khoolna	...	...	0·18	...	0·80	0·45	...	...	0·10	...	0·18
		Jhenidah	...	...	0·58	0·18	0·08	...	...	...	...	0·81	0·02
		Bagirhat	0·50	0·45	...	...	0·70	1·50	...	...	...	...	0·35
		Magoora	0·64	...	0·34	...	...	0·25	...	...	...	...	...

BENGAL AND ASSAM IN SEPTEMBER 1878.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL.
1·40	0·88	0·64	...	0·10	0·02	...	...	0·57	...	3·80	1·04	0·21	0·07	...	0·03	0·07	...	...	10·33
3·87	0·55	...	0·25	...	...	...	...	...	...	4·65	2·00	0·51	...	...	...	0·04	...	...	18·90
2·41	...	...	...	...	0·43	...	...	2·22	0·18	4·90	0·80	...	...	...	...	...	...	...	13·60
0·73	...	0·12	0·26	...	...	0·33	...	0·70	...	3·63	1·70	0·50	0·40	...	...	...	...	...	9·65
0·53	...	0·75	1·03	0·03	0·06	...	...	0·12	...	0·97	0·30	0·04	0·61	...	...	...	...	...	5·95
0·13	0·57	...	...	...	...	...	0·50	0·15	0·09	8·77	1·40	...	...	...	...	0·44	...	...	14·81
0·53	...	0·36	0·30	0·17	0·10	...	...	...	...	2·92	1·07	0·13	0·08	...	...	...	...	...	8·57
1·98	...	0·15	0·79	0·38	...	0·05	0·02	...	0·04	1·74	2·75	0·44	0·23	...	...	...	...	0·05	13·09
2·32	...	0·03	0·09	0·10	0·15	...	...	...	...	7·50	2·72	0·05	...	...	...	4·50	0·10	...	23·53
1·15	...	0·27	0·15	0·07	0·09	...	...	...	...	6·62	2·82	0·77	...	...	...	0·09	...	...	14·45
0·57	0·46	0·07	1·28	0·24	...	...	...	...	0·06	2·70	0·16	0·34	0·10	...	1·20	...	...	...	9·93
...	0·60	0·38	0·89	0·80	...	...	0·10	...	0·70	4·80	...	...	...	0·10	...	...	...	0·35	11·62
0·05	0·17	...	...	0·18	...	...	...	0·43	...	11·08	0·59	0·53	...	0·46	...	1·37	...	...	18·29
1·77	1·77	0·57	0·37	...	...	...	...	0·37	...	3·47	...	...	...	...	0·27	0·67	0·87	...	11·90
2·24	0·13	0·06	0·01	0·28	0·24	...	0·09	0·01	0·03	8·40	0·85	1·51	...	...	0·27	0·52	...	...	18·12
1·28	0·32	0·08	0·20	0·12	0·37	...	...	...	0·41	14·32	0·45	0·88	0·02	...	...	0·02	...	0·62	20·70
1·00	0·96	0·15	0·15	...	0·20	...	...	0·55	0·45	5·60	...	0·15	...	0·08	0·05	0·12	...	0·08	11·07
0·20	...	0·12	...	0·05	0·25	...	...	1·18	...	8·23	0·15	0·26	...	0·05	...	0·57	...	1·06	14·25
0·27	0·85	2·39	0·67	0·41	0·08	...	...	0·60	..	1·24	0·04	...	...	0·22	...	0·47	0·19	0·10	9·52
0·46	...	0·34	0·16	...	0·09	...	...	...	0·14	...	6·28	0·05	0·10	0·21	0·06	0·08	...	0·62	10·14
0·69	0·10	0·16	0·10	...	0·52	...	0·22	...	0·09	6·64	0·06	0·02	0·09	0·45	0·01	1·05	0·55	0·54	12·93
0·60	0·66	0·80	0·24	0·04	...	...	...	...	0·07	2·30	0·10	1·74	...	0·01	0·08	0·07	...	...	8·50
1·00	0·44	0·26	0·40	0·07	0·01	...	0·19	0·02	0·89	12·32	0·12	0·63	0·02	...	...	1·56	...	...	19·70
...	0·34	0·49	0·16	...	0·20	...	0·10	...	1·10	2·50	0·14	0·02	...	...	0·24	...	...	0·12	12·32
0·10	0·50	0·30	0·60	0·10	...	0·30	...	...	0·21	2·99	0·22	0·35	0·06	0·64	0·08	0·24	...	0·10	8·04
...	1·05	0·60	0·25	0·20	...	0·20	...	...	0·01	0·95	0·60	1·50	0·60	...	0·85	0·21	0·06	...	11·27
1·53	0·37	0·09	0·19	0·35	0·18	...	...	...	0·36	11·87	...	1·00	...	...	...	0·05	...	0·64	21·08
...	0·98	0·26	0·35	0·25	0·15	...	...	0·06	0·75	7·90	0·63	0·07	...	...	...	...	...	1·00	16·25
1·32	0·90	...	0·11	0·29	...	...	...	0·11	...	2·38	1·05	0·41	...	...	...	...	...	...	9·19
3·33	...	0·33	...	...	...	...	...	...	6·60	3·15	0·35	2·06	0·35	...	...	...	...	...	14·57
0·46	...	0·36	...	...	...	...	...	...	...	1·30	4·10	1·60	...	...	1·10	0·60	...	...	12·03
9·35	0·28	...	0·02	...	0·02	...	...	...	0·16	0·70	3·50	0·66	...	0·02	2·05	0·10	0·03	0·22	21·97
3·53	0·14	0·04	0·14	...	...	0·16	...	0·12	...	2·12	4·68	1·65	0·85	...	...	0·04	0·42	0·32	15·74
5·20	0·25	...	0·50	...	...	...	...	0·15	...	2·00	2·00	1·00	...	...	0·21	...	...	0·31	15·06
0·83	0·40	0·27	0·03	0·80	0·31	...	...	...	1·82	2·44	1·61	1·33	0·45	...	0·22	0·16	...	...	11·22
2·48	0·62	0·15	...	...	...	...	0·55	...	0·54	0·90	0·94	0·36	0·32	0·14	0·41	0·13	...	...	8·68
2·10	...	0·32	...	0·70	0·15	...	...	0·10	...	0·50	1·40	0·47	0·12	...	0·16	...	...	...	7·73
2·38	0·55	0·25	...	...	...	...	...	...	0·83	2·15	2·42	2·37	1·28	...	0·55	0·03	0·25	0·50	15·23
0·25	0·70	...	...	0·45	0·90	...	...	...	0·75	...	0·60	1·00	...	...	0·75	...	...	...	8·90
2·78	0·54	0·12	...	...	...	...	...	...	0·34	2·40	1·80	4·01	0·59	0·77	0·10	0·36	...	1·75	16·79

Table of Rainfall recorded at Stations in

Divisions.	Districts.	Stations.	1	2	3	4	5	6	7	8	9	10	11
BENGAL—contd.		Berhampore	0·12	0·84	...	0·43	0·40	0·04	...	...	...	0·85	0·31
		Rampore Haut	...	...	...	...	0·09	0·16	...	...	0·66	0·30	...
		Lalbagh	0·08	...	0·58	0·70	0·06	...	...	...	...	...	0·75
PRESIDENCY —contd.	Moorshedabad	Jungypore	0·25	...	0·24	0·10	0·45	0·10	...	...	...	...	...
		Azimgunge	...	1·85	...	0·32	...	0·02	...	...	...	0·29	0·17
		Lalgola	0·60	0·10	0·08	1·94	...	...	...	0·11	...	...	0·04
		Kandi	0·06	0·31	...	0·04	1·23	...	...	...	...	0·31	...
		Dinagepore	0·84	1·50	...	0·15	0·02	0·47	0·06	0·70	0·46	0·09	0·75
	Dinagepore	Raigunge	...	0·39	...	0·23	...	1·44	1·91	...	0·69	...	2·01
		Mohadebpore	0·70	0·74	...	0·50	0·15	0·10	...	...	...	0·35	0·03
	Maldah	Maldah	0·18	0·58	0·08	0·15	0·27	1·38	0·04	...	...	1·30	0·98
		Chanchal	0·02	0·06	0·39	...	0·10	0·04	0·80	...	0·20	0·02	...
	Rajshahye	Bauleah	0·04	0·44	0·09	0·22	...	0·29	...	...	...	...	1·03
		Nattore	0·33	2·12	0·44	0·10	...	...	...	...	...	0·75	0·51
RAJSHAHYE	Rungpore	Rungpore	0·55	0·11	1·95	...	...	...	...	0·10	0·97	2·62	0·83
		Bhabanigunge	...	1·66	0·59	...	...	...	0·45	0·16	0·35	1·32	1·25
		Kurigram	0·40	0·20	1·05	...	...	...	...	0·40	0·72	3·24	5·61
		Bogdogra	0·82	0·74	1·36	1·44	...	...	6·55	0·95	2·37	3·35	0·47
	Bogra	Bogra	...	1·13	0·61	...	0·03	...	0·18	...	0·11	0·62	0·95
		Nowkhilla	0·08	...	0·15	...	...	...	0·17	...	0·05	0·11	0·98
		Panchbibi	...	0·32	...	...	...	...	...	...	...	3·46	4·24
		Sherpore	2·04	2·93	0·60	...	...	0·05	...	...	...	0·30	2·00
	Pubna	Pubna	0·94	0·41	...	0·61	...	0·52	0·11	0·05	...	...	1·10
		Serajgunge	...	1·50	0·12	...	...	...	0·02	...	...	...	1·50
	Darjeeling	Darjeeling	0·76	...	2·57	0·36	...	1·52	1·16	...	0·34	0·23	0·99
	Julpigoree	Julpigoree	0·29	1·19	2·30	0·27	...	0·10	0·92	3·99	2·88	3·29	2·34
		Buxa	0·45	2·17	2·31	...	0·77	0·97	1·09	0·03	0·45	1·32	5·46
COOCH BEHAR.		Boda	...	0·39	0·86	...	0·39	0·21	...	5·24	2·13	1·03	3·07
		Titalya	0·17	1·57	0·26	...	1·43	0·26	...	3·03	3·39	1·49	7·62
	Cooch Behar T. States	Cooch Behar	3·50	2·76	3·40	...	...	...	...	7·75	2·75	3·36	1·25
	Dacca	Dacca	0·30	1·68	0·16	0·10	0·70	0·33	0·80	0·90	...	...	0·17
		Moonsheegunge	...	3·50	0·10	...	0·30	...	...	...	...	...	...
		Manickgunge	1·73	0·10	1·50	0·12	...	...	...	...	...	0·10	2·50
	Furreedpore	Furreedpore	0·15	0·06	0·11	0·28	...	...	...	...	0·20	0·02	2·25
DACCA		Goalundo	0·15	...	0·55	...	...	...	0·25	...	...	0·25	0·28
		Madareepore	...	0·40	...	...	...	...	...	...	0·28	...	...
	Backergunge	Burrisal	0·01	0·76	0·48	...	0·21	0·03	0·03	0·01	...	...	0·42
		Ferozepore	0·96	0·45	...	...	0·46	1·00	...	0·12	...	...	...
		Patoakhally	...	0·59	...	0·08	0·16	0·42	0·15	...	0·12	...	...
		Bhola	...	0·91	0·09	...	0·70	0·07	0·36	...	...	...	...

Bengal and Assam in September 1878—contd.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL.
3·77	0·52	1·19	0·49	0·07	...	...	...	0·07	0·75	1·88	4·59	0·06	...	...	2·53	...	0·09	...	19·00
2·94	0·02	1·11	0·65	...	...	...	...	...	0·75	0·90	0·78	...	...	0·05	...	...	...	0·80	9·21
3·29	0·05	1·18	...	...	...	...	...	...	0·48	1·21	3·72	...	...	...	0·65	0·36	0·13	...	13·24
2·58	...	1·21	...	...	...	...	...	...	0·61	3·30	1·62	0·06	...	...	...	...	0·45	...	10·97
2·00	0·15	1·16	...	...	...	...	...	...	0·25	1·29	2·42	...	...	...	2·55	0·20	...	...	12·67
3·14	...	0·60	...	...	...	...	...	...	1·73	1·63	3·28	0·09	...	...	0·20	0·11	...	...	13·65
4·16	...	4·00	0·05	...	...	...	...	...	0·52	3·24	3·95	0·24	...	...	...	0·21	0·10	0·15	17·87
1·13	...	...	...	...	...	...	0·22	...	...	0·85	0·40	0·04	...	0·20	...	...	...	...	7·88
2·53	...	...	...	...	...	...	0·52	0·34	0·10	0·20	0·40	0·47	...	0·64	...	...	...	...	11·87
5·02	0·10	...	...	...	0·50	0·51	...	1·02	...	1·02	0·40	...	...	...	0·30	...	....	1·40	12·84
1·20	0·30	...	...	...	...	...	...	...	...	...	1·02	0·50	...	...	...	...	...	...	7·98
1·60	0·55	0·06	...	...	...	...	0·05	...	...	0·48	0·06	0·29	0·02	...	0·86	...	0·43	...	6·03
2·89	0·67	0·35	...	...	...	...	...	...	...	2·48	5·48	0·08	...	...	1·07	0·06	...	...	15·19
4·98	...	1·10	...	...	...	...	...	...	0·49	4·66	2·16	1·39	...	...	0·70	0·19	...	...	19·92
6·63	0·55	...	...	...	...	...	...	...	...	0·39	2·85	1·76	...	...	0·30	...	...	...	19·61
1·53	0·21	...	...	...	...	...	...	...	...	...	2·46	1·35	...	...	...	...	...	...	11·33
0·54	1·52	...	...	...	...	...	...	...	...	0·41	11·44	2·45	...	...	...	...	...	...	27·98
3·27	0·91	...	...	...	0·26	...	...	...	...	0·31	7·60	4·96	0·85	...	...	0·05	...	...	30·26
2·99	...	...	...	...	...	...	...	...	...	0·20	3·23	0·30	0·02	...	...	...	0·08	0·30	10·75
1·93	...	...	...	...	...	...	...	...	0·17	0·65	6·20	2·55	0·02	...	...	...	...	...	13·06
3·82	...	...	...	...	...	...	...	...	...	2·46	3·32	1·62	...	...	...	...	...	...	19·24
2·30	...	...	...	...	...	...	0·17	...	0·74	0·40	8·35	0·73	0·90	...	...	0·22	0·05	...	21·78
3·30	0·15	...	...	...	...	0·80	...	...	...	1·55	2·95	1·18	0·20	0·09	...	0·57	0·32	0·50	15·35
3·50	0·20	...	...	...	...	...	...	...	...	3·10	0·30	0·90	...	...	...	...	...	...	11·14
5·42	1·36	1·18	...	...	0·03	...	0·46	...	...	0·59	0·64	2·43	1·83	0·24	...	0·66	0·42	...	29·19
1·97	0·62	0·06	...	...	...	...	...	...	...	0·17	3·70	7·13	0·07	...	...	...	0·09	...	31·38
2·06	0·24	...	...	...	...	0·44	...	0·12	...	1·50	3·97	4·64	...	0·12	0·44	...	1·15	1·57	31·27
0·08	0·05	...	...	...	...	...	...	...	1·15	...	5·00	7·00	0·85	...	...	...	...	...	27·45
0·42	0·02	...	...	...	...	...	...	...	0·76	0·73	7·23	2·47	...	...	...	...	...	...	30·85
0·46	0·44	...	...	...	...	...	...	...	...	2·00	8·85	8·45	...	...	...	...	...	...	44·97
2·80	0·30	0·40	...	...	...	0·22	...	0·90	0·16	0·22	2·49	1·76	...	...	0·92	...	...	...	15·31
1·70	0·15	...	...	...	0·25	...	...	1·50	0·65	0·95	...	0·15	...	0·55	1·05	...	...	...	10·85
0·65	0·02	...	...	...	...	...	...	...	0·02	0·52	3·58	2·23	0·25	0·08	...	0·04	0·10	...	13·54
0·07	0·02	...	...	...	...	0·42	...	...	0·65	0·74	1·62	1·16	0·08	0·01	0·05	0·22	0·38	...	8·49
2·38	...	...	...	...	...	0·35	...	0·35	0·05	1·10	0·98	1·70	0·44	...	0·31	...	...	1·65	10·81
0·22	...	...	...	...	...	...	...	0·45	0·98	...	...	3·00	0·50	...	0·05	0·50	...	...	6·38
0·05	0·37	0·10	0·99	0·11	...	...	...	...	0·48	1·97	0·47	0·03	0·24	0·01	0·99	0·15	0·23	0·01	8·15
0·40	0·22	0·12	1·35	0·35	...	...	...	...	0·38	0·75	0·49	...	1·70	...	0·47	...	0·96	...	10·09
0·22	0·34	0·28	0·57	0·15	...	...	...	...	0·39	0·62	...	...	0·06	...	...	...	...	...	4·15
0·12	0·69	0·66	0·44	0·18	...	...	...	0·15	0·32	0·72	...	...	0·07	...	0·04	...	0·72	...	6·2

Table of Rainfall recorded at Stations in

Divisions.	Districts.	Stations.	1	2	3	4	5	6	7	8	9	10	11
BENGAL—concld.													
Dacca	Mymensingh	Mymensing	0·58	1·93	1·46	0·07	...	...	0·16	0·08	0·17	0·94	3·53
		Jamalpore	0·47	5·10	0·40	...	...	0·44	0·90	...	0·91	0·10	1·09
		Atia	0·35	1·49	0·64	...	...	...	...	...	...	0·49	0·44
		Kishoregunge	...	0·82	1·35	...	...	...	0·19	...	...	0·32	2·50
Chittagong	Chittagong	Chittagong	0·42	0·20	...	...	1·81	0·21	0·50	0·10	...	0·06	0·07
		Cox's Bazar	0·74	...	0·06	0·10	0·28	0·40	0·13	0·11	...	0·19	0·16
	Noakhally	Noakhally	...	0·95	0·09	...	...	1·02	0·50	0·05	...	...	0·50
		Fenny	0·10	0·03	0·03	...	0·80	...	2·05	...	0·10	0·50	0·23
	Tipperah	Comillah	...	1·38	1·70	...	3·00	...	0·05	...	...	0·39	0·20
		Brahmunbariah	0·80	0·65	0·90	...	0·51	...	...	...	1·74	1·01	1·05
		Chandpore	0·02	0·50	0·02	...	0·25	0·03	...	...	0·10	...	...
	Chittagong Hill Tracts	Rangamatee	0·44	0·15	0·76	...	0·94	...	...	0·25	0·33	0·36	0·78
		Rama	0·21	0·70	0·05	...	...	...	0·76	2·11	...	0·42	0·11
	Hill Tipperah	Hill Tipperah	...	0·80	1·21	0·91	0·45	...	...	...	...	...	0·30
BEHAR.													
Patna	Patna	Patna	...	0·44	...	0·20	...	...	...	...	...	...	0·38
		Behar	...	0·27	0·03	0·04	0·36	0·27	...	...	0·50	0·44	...
		Barh	...	...	0·80	...	...	...	0·35	0·15	...	...	...
		Dinapore	0·10	...	...	...	...	...	...	...	...	...	...
	Gya	Gya	...	0·18	0·27	...	0·14	0·20	0·01	...	1·73	...	0·28
		Nowada	...	0·40	...	...	0·50	...	...	...	0·25	2·25	...
		Aurungabad	...	0·39	0·36	0·07	...	...	...	0·12	0·17	...	...
		Jehanabad	...	...	0·68	...	0·40	...	...	...	0·42	...	...
	Shahabad	Arrah	...	...	...	...	0·15	...	...	0·10	...	...	0·04
		Sasseram	...	...	0·01	...	0·08	...	...	1·14	0·39	0·05	0·35
		Buxar	...	...	...	...	...	...	0·26	0·06	0·01	...	...
		Bhubooah	...	0·15	...	0·15	0·15	...	...	2·05	...	...	...
Patna	Mozufferpore	Mozufferpore	0·08	0·53	1·63	...	0·26	0·04	...	0·61	...	...	0·10
		Hajeepore	0·22	0·45	0·05	0·08	0·50	...	...	0·33	...	...	...
		Seetamarhee	...	0·12	0·39	0·27	...	0·08	...	...	1·06	...	0·41
	Durbhunga	Durbhanga	...	0·30	0·21	0·91	...	0·21	...	0·07	0·15	...	0·10
		Mudhoobunee	...	0·23	2·55	0·22	...	0·10	...	0·32	...	...	0·65
		Tajpore	...	...	...	1·75	...	...	0·20	1·23	0·34	...	...
	Sarun	Chupra	...	...	0·38	0·07	0·23	...	...	...	...	...	...
		Sewan	...	1·85	0·21	...	...	0·18	...	...	...	...	0·70
		Gopalgunge	0·46	0·84	...	0·50	...	...	...	...	0·80	...	0·15
	Chumparun	Motihari	...	0·60	0·30	...	...	0·39	...	0·36	1·05	...	0·11
		Bettiah	...	...	...	0·33	0·22	...	...	...	0·52	...	...
		Segowlie	0·49	3·16	0·11	2·11	...	0·03	0·10	...	1·70	0·11	...
Bhagulpore	Monghyr	Monghyr	...	0·21	1·24	0·13	...	0·15	0·03	0·30	0·16	0·01	...
		Begoo Serai	0·44	...	0·72	1·09	...	0·12	...	0·11	...	...	...
		Jamoocee	...	0·48	...	...	1·28	0·05	0·78	...	...	1·18	...

Bengal and Assam in September 1875—contd.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL.
3·14	3·10	0·05	...	...	...	...	...	...	0·92	1·24	6·20	4·18	0·17	...	.	1·34	0·12	...	29·38
3·03	...	...	...	...	...	...	...	...	0·29	0·47	3·97	2·45	0·65	0·03		0·29	...	...	20·59
1·01	...	...	...	...	...	...	...	...	...	0·86	8·05	4·11	0·53	...	0·13	...	...	...	18·10
5·05	1·49	...	...	...	...	...	...	...	0·02	0·45	6·23	0·85	...	...	1·90	0·05	...	...	21·22
0·22	0·38	2·53	0·22	...	...	0·15	...	0·05	0·44	2·70	3·42	1·31	...	0·03	1·23	..	...	0·14	16·19
0·51	0·02	0·15	0·20	0·05	...	...	...	...	0·54	3·00	1·11	4·38	...	0·21	2·45	0·16	0·07	0·03	15·05
0·40	0·84	0·23	...	0·20	...	0·15	...	1·95	1·72	5·25	0·76	2·62	0·05	...	0·50	0·54	...	0·28	18·60
0·28	...	1·70	1·00	...	...	1·50	...	0·40	1·00	2·01	3·33	1·02	...	...	0·46	0·34	0·05	0·08	17·01
1·17	0·39	0·12	...	...	...	0·01	...	...	...	0·97	0·43	0·05	0·81	...	2·30	0·17	...	0·28	13·43
1·16	2·90	0·09	...	...	..	...	...	...	0·40	0·43	0·70	0·10	0·07	...	0·15	0·04	...	...	12·79
0·50	0·30	0·80	0·20	...	...	...	...	1·60	0·25	0·70	0·20	0·05	1·05	0·80	0·70	0·75	...	...	8·82
0·08	...	1·25	2·29	1·15	...	...	...	...	0·90	1·87	2·16	0·84	0·02	0·04	...	1·02	...	...	15·63
...	0·30	2·60	...	0·05	...	2·40	...	0·40	...	2·08	1·40	0·54	0·40	3·48	0·60	0·70	...	1·80	21·11
1·65	1·39	...	...	0·24	...	1·70	...	0·21	0·05	1·29	0·85	0·30	0·54	...	..	0·04	...	0·90	12·83
1·18	0·04	...	...	...	0·16	...	...	...	0·56	0·05	0·28	...	0·14	0·12	0·32	...	...	...	3·87
0·18	1·12	0·07	0·09	0·22	...	0·03	...	...	...	0·05	0·13	0·14	0·23	0·83	...	...	...	...	5·00
...	0·27	...	0·35	...	...	...	...	...	1·08	...	0·55	...	0·21	1·06	0·12	...	...	...	4·94
2·75	...	...	...	...	0·14	...	...	...	...	2·41	...	...	0·15	0·15	...	...	...	...	5·70
0·16	0·30	0·42	0·54	...	0·20	...	...	...	0·27	1·51	1·67	0·37	...	0·43	0·62	...	...	...	9·30
0·10	1·80	...	...	...	...	0·40	...	0·50	0·35	0·50	...	...	0·10	0·20	...	...	...	...	7·35
...	0·35	...	...	...	...	...	...	1·97	...	...	...	...	...	0·58	...	...	...	...	4·01
0·57	...	...	...	...	...	...	...	...	0·72	...	...	...	...	...	...	...	...	...	2·79
...	0·20	...	...	...	0·70	...	...	...	0·09	0·20	2·97	...	0·97	...	0·21	...	...	...	5·63
0·34	0·16	...	0·86	...	...	...	...	...	...	0·43	0·41	0·08	...	...	...	...	...	...	4·30
0·29	0·09	0·06	...	...	...	...	...	...	...	...	0·10	...	0·43	0·24	1·58	...	...	...	3·12
0·40	1·00	0·80	0·52	...	...	...	...	0·22	...	0·60	...	...	...	...	...	...	...	...	6·04
0·26	...	...	...	...	...	...	...	...	0·07	...	...	0·38	1·09	0·30	...	...	...	...	5·35
0·22	0·01	...	...	...	...	...	...	...	0·40	0·02	0·02	...	0·51	0·74	...	...	...	...	3·55
0·63	...	...	...	...	...	...	...	...	0·34	0·83	...	0·10	0·56	0·25	2·15	...	...	...	7·19
...	...	...	...	...	...	...	...	...	0·10	0·16	0·17	...	0·37	0·66	...	...	...	...	3·41
0·18	...	...	...	...	...	...	...	...	0·25	0·22	0·37	0·95	0·60	0·33	0·36	...	...	...	7·33
0·06	...	...	...	...	...	...	...	...	0·70	0·06	0·20	0·18	2·02	1·50	0·30	...	...	...	8·54
1·54	...	...	0·10	...	0·11	...	...	...		...	1·16	...	0·15	1·38	0·44	...	...	...	5·56
2·84	...	...	...	...	...	...	...	...	0·54	0·95	0·97	...	0·24	0·36	0·35	...	...	...	9·36
1·20	...	...	...	...	...	0·03	...	...	0·30	0·15	0·22	0·11	0·20	0·80	0·26	...	...	...	6·02
0·19	...	...	...	...	...	...	...	...	...	0·15	...	...	...	0·89	1·28	...	...	...	5·32
0·25	...	...	...	...	...	...	0·06	...	0·15	1·00	0·06	0·19	1·00	0·52	1·12	...	...	...	5·42
0·55	...	0·04	...	...	...	...	...	...	0·08	1·49	0·06	...	0·77	0·37	1·11	...	...	...	12·28
0·89	0·09	...	...	0·01	0·05	...	...	...	...	0·01	0·33	1·87	0·10	0·70	0·11	...	...	...	6·39
...	...	...	...	...	0·09	...	...	...	...	...	...	1·62	0·05	...	0.13	...	...	..	4·37
0·19	0·28	...	0·05	0·06	...	...	...	...	1·78	0·52	1·79	0·14	0·45	0·05	...	...	...	...	9·08

Table of Rainfall recorded at Stations in

Divisions.	Districts.	Stations.	1	2	3	4	5	6	7	8	9	10	11
BEHAR—concld.													
Bhagulpore Division	Bhagulpore	Bhagulpore	...	0·10	0·28	0·12	0·45	0·25	...	0·49	...	0·81	0·27
		Soopole	...	0·40	1·00	3·50	...	...	2·10	...	0·60	...	1·84
		Muddehpoora	...	0·60	0·70	1·60	...	0·10	...	...	1·10	...	...
		Banka	1·05	0·10	...	0·25	...	0·33	...	...	0·12	0·28	...
		Sonbursa	0·40	...	0·25	1·80	...	...	...	1·43	...	...	...
	Purneah	Purneah	...	...	0·49	0·71	0·42	0·43	0·47	0·34	2·57	0·31	...
		Kissengunge	...	...	2·80	1·58	...	...	0·18	0·20	4·25	1·15	...
		Arrareah	...	...	2·70	...	...	0·62	...	0·50	5·86	0·50	...
	Sonthal Pergunnahs	Nya Doomka	0·03	0·08	0·46	0·05	0·01	0·38	0·22	...	0·98	1·56	0·04
		Deoghur	0·10	0·07	0·18	0·03	0·13	0·11	...	...	2·74	0·98	0·45
		Rajmehal	0·10	...	1·07	0·12	0·72	0·06	0·23	...	...	0·36	1·18
		Godda	...	...	0·21	...	...	...	...	...	0·26	...	...
		Jamtara	...	...	...	0·45	2·30	...	...	...	...	0·97	0·17
		Pakour	2·80	0·20	...	...	...	0·68	...	0·03	1·50	0·02	1·25
ORISSA													
Orissa Division	Cuttack	Cuttack	...	...	...	1·50	0·23	0·52	0·02	0·05	...	0·13	...
		Jajpore*											
		Kendrapara	...	...	...	0·30	...	0·30	0·20	...	0·50	...	...
		Jugutsingpore	...	...	...	0·70	0·90	0·20	0·60	...	0·03	...	...
		False Point	...	1·60	...	0·22	...	1·19	0·25	0·05	0·03	...	...
	Pooree	Pooree	...	...	...	...	0·39	...	...	0·12	0·06	...	...
		Khoordah	...	...	...	...	0·82	0·40	0·27	...	1·43	0·04	...
ORISSA	Balasore	Balasore	...	...	...	0·35	0·12	0·15	...	...	...	...	...
		Bhuddruck	...	...	...	...	0·97	1·05	0·45	0·25	...	...	...
		Jellasore	...	...	...	2·28	1·10	0·31	...	...	...	...	...
		Sora	...	...	...	0·32	0·08	0·27	...	...	...	...	...
		Chandbally	...	...	...	...	0·25	0·07	...	0·01	...	0·50	...
	Cuttack T. Mehals	Sumbulpore	...	...	...	...	0·25	0·03	...	...	...	0·68	...
CHOTA NAGPORE.													
Chota Nagpore	Hazaribagh	Hazaribagh	0·54	0·22	0·05	0·63	0·03	0·02	...	0·01	0·02	1·11	0·14
		Pachumba	0·82	0·17	0·12	1·00	0·29	0·05	...	...	1·11	0·42	0·11
		Sitagurrah	1·00	...	0·21	0·71	0·05	0·15	...	0·06	0·08	0·56	...
		Mowdie Hill	...	...	...	2·10	...	...	...	...	...	0·83	...
	Lohardugga	Ranchee	...	0·84	0·50	0·58	0·02	0·07	0·44	...	...	...	0·73
		Palamow	0·07	0·70	0·40	1·40	0·20	0·15	...	0·12	...	1·02	0·36
	Singbhoom	Chyebassa	0·53	0·95	...	0·06	0·18	0·15	...	...	...	0·71	0·01
	Manbhoom	Purulia	0·44	...	0·36	0·20	...	0·04	...	...	...	0·18	0·15
		Govindpore	0·31	...	...	0·83	...	...	...	...	0·75	0·22	...
ASSAM AND ADJACENT HILLS.													
Assam	Sylhet	Sylhet	6·69	4·19	1·07	...	0·29	0·20	1·09	0·96	2·76	1·67	5·31
		Sonamgunge	0·78	2·71	0·15	...	0·13	...	3·40	0·39	0·30	2·70	12·10

* Not recorded from

Bengal and Assam in September 1878—contd.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL.
..	...	0·54	0·88	.	...	...	...		...	0·82	...	0·60		0·07	..			...	5·68
2·40	0·34	...	...	...	...	...	.	..	0·50	..	0·25	..	1·80	...	2·70	..	.	.	17·43
2·40	0·60	...	...	...	...	...	...	...	..	0·60	0·60	..	3·50	...	3·10	.	...	...	14·90
0·22	0·10	...	0·10	...	...	...	...	0·10	0·15	1·00	0·12	0·75	.	0·50	0·80	...		.	6·27
0·80	..	...	...	...	...	...	...	..	0·19	0·60	0·30	0·60	0·19	0·60	0·20	1·23		..	8·59
3·45	5·26	...	...		...	...	..	...	0·10	0·64	. .	0·42	0·27	...	0·22	...	...		16·10
2·05	1·16	...	...	...	...	...	...	. .	...	1·14	2·03	1·11	0·45	..	0·11	...	...	...	18·21
3·56	1·00	...	...	...	...	.	...	.	..	1·45	0·50	0·50	0·30	. .	0·35	...	.	0·45	18·29
0·54	...	0·08	0·57	0·03	...	..	...	...	...	3·40	2·30	0·02	0·35	0·13	...	1·90	0·02	...	13·15
0·23	0·12	...	...	0·07	0·09	...	...	0·09	0·12	0·87	3·00	0·74	1·61	0·04	...	0·09	...	0·37	12·23
2·47	0·04	0·31	...	...	...	...	...	...	...	0·53	0·38	0·31	0·24	0·49	0·39	0·24	...	...	9·24
0·21	...	...	...	...	...	...	2·74	...	0·92	1·72	0·27	0·15	...	0·43	3·20	...	...	...	10·11
0·29	.	...	1·85	...	0·65	...	...	...	...	0·60	0·42	0·23	0·15	...	0·11	...	...	...	8·19
...	0·22	...	...	...	...	...	...	...	0·18	0·33	3·83	0·10	. .	...	...	0·89	...	...	12·03
0·06	1·30	0·40	0·85	0·40	0·40	...	...	0·07	0·06	0·14	0·42	...	0·05	...	0·02	...	0·22	0·06	6·40
1·90	0·50	1·90	0·40	0·30	0·90	0·10	0·20	...	...	0·56	1·27	0·34	...	0·25	0·18	0·70	0·10	1·40	12·30
0·29	0·03	0·08	0·80	0·30	...	...	...	.	0·60	0·90	...	0·70	0·40	0·50	1·30	0·80	0·70	0·70	10·53
0·96	...	1·67	0·14	0·81	1·06	...	0·70	...	0·50	0·56	1·27	0·34	...	0·25	0·18	0·76	...	0·15	12·69
1·72	0·89	2·46	0·20	0·65	0·50	0·99	...	2·21	0·15	0·11	...	...	...	1·18	0·05	0·81	0·95	0·12	13·56
...	0·58	0·12	1·15	0·31	0·08	...	0·11	0·98	0·01	...	0·13	...	0·12	...	0·67	0·09	...	0·10	7·41
0·25	0·60	0·35	1·35	0·66	...	...	0·11	...	0·15	1·79	0·10	0·02	0·05	...	...	1·75	0·10	...	7·90
...	...	0·88	1·12	0·14	0·85	...	...	...	1·65	1·30	...	...	...	...	0·36	0·16	...	...	9·18
0·42	...	...	1·34	0·65	...	..	...	0·34	...	2·70	...	..	...	...	0·72	...	...	..	9·86
...	0·40	2·85	0·30	0·15	0·42	...	...	...	1·01	0·22	...	0·20	0·04	...	0·72	0·32	...	...	7·30
...	...	1·75	0·16	0·94	0·78	...	...	...	0·14	0·70	0·11	...	.	...	1·55	0·40	0·40	0·25	7·96
1·00	0·37	0·64	0·08	0·15	1·60	0·10	...	...	...	0·25	0·12	...	...	...	...	0·12	...	0·42	5·81
0·13	0·80	0·23	0·56	0·12	0·25	0·02	0·55	0·01	0·26	...	0·38	...	..	0·05	...	0·22	0·66	0·14	7·15
0·86	0·30	0·05	0·50	0·13	0·41	0·46	...	...	.	..	0·50	...	...	1·10	0·02	...	...	...	8·42
0·03	0·10	0·05	0·05	0·13	0·13	...	0·56	...	...	...	0·73	...	...	0·25	..	0·15	0·36	..	5·36
0·68	0·25	0·42	...	0·35	...	...	...	...	0·50	...	0·30	. .	...	0·38	...	...	...	0·25	6·06
0·26	1·58	0·37	0·44	0·38	0·14	0·11	...	...	2·26	0·26	0·12	..	1·30	...	0·08	...	...	0·02	10·50
0·03	...	0·22	0·07	0·03	0·04	0·45	...	...	...	0·50	0·03	..	0·20	..	...	...	...	...	5·99
0·61	0·42	1·15	0·23	0·37	0·53	0·06	0·27	0·01	...	0·03	0·07	0·08	0·04	0·02	...	...	0·18	...	6·66
4·16	0·19	0·76	0·27	0·68	0·22	...	...	0·45	2·68	2·68	0·14	0·18	0·06	0·09	...	. .	...	...	13·93
1·32	...	0·42	...	0·65	...	...	...	...	...	...	...	...	..	0·82	...	...	..	0·85	6·17
0·45	0·17	...	...	...	...	..	...	. .	...	.	1·55	2·49	...	...	..	...		. .	28·89
6·30	1·53	2·30	0·50	0·20	...	1·20	0·10	0·20	0·30	1·30	1·39	3·55	0·88	...	...	.	1·39		43·80

28th July 1878.

Table of Rainfall recorded at Stations in

Divisions.	Districts.	Stations.	1	2	3	4	5	6	7	8	9	10	11
Assam and adjacent Hills—concld.													
Assam—concld.	Cachar	Silchar	0·29	3·13	1·48	...	4·08	1·47	2·28	2·21	1·52	0·24	1·30
		Hylakandy	0·40	2·54	0·46	0·20	3·20	...	0·15	0·10	0·95	0·06	0·50
		Jafferbund	0·23	2·20	0·93	...	4·21	0·20	0·31	0·12	0·45	0·29	0·76
		Koya	0·03	1·76	0·88	...	5·14	0·23	0·54	0·09	0·34	0·09	0·82
	Goalpara	Goalpara	0·17	2·05	2·50	0·02	...	0·07	0·59	0·16	0·71	1·18	3·62
		Dhubri	0·03	0·35	2·23	...	...	...	...	0·15	3·54	4·00	1·00
	Garo Hills	Tura	1·40	3·10	0·88	1·70	0·03	...	0·48	...	1·57	4·24	2·23
		Gauhati	0·01	1·30	0·50	...	...	...	...	...	1·06	...	1·52
	Kamrup	Burpeta	0·06	1·35	1·16	...	...	...	...	0·20	0·30	0·34	2·10
	Darrang	Tezpur	0·15	0·19	...	...	0·42	0·40	0·32	0·84	0·35	0·28	1·50
		Mungaldai	0·20	0·37	0·85	...	...	0·02	0·07	0·05	0·28	0·02	2·71
		Adabari	0·12	0·25	0·43	...	0·93	2·74	0·08	0·55	0·14	1·03	0·73
	Nowgong	Nowgong	...	0·24	0·12	...	...	...	0·57	2·02	0·91	0·19	1·91
	Sibsagar	Sibsagar	1·23	0·19	...	1·45	0·65	0·34	0·48	0·77	0·75	1·29	0·96
		Jorhat	0·90	0·80	0·19	0·50	...	0·90	0·80	1·25	1·25	1·00	2·25
		Golaghat	0·72	0·20	0·15	...	...	0·92	0·12	0·45	0·66	1·89	1·26
	Lakhimpur	Dibrughar	1·00	1·07	1·06	...	0·15	2·05	0·36	1·10	0·05	0·82	3·00
		Sadiya	1·58	3·50	0·70	...	0·27	1·05	...	0·99	0·91	0·85	5·95
		North Lakimpur	1·77	1·42	0·13	...	...	0·08	1·23	3·33	1·09	0·20	1·21
		Jaipur	0·13	0·09	...	...	0·18	0·89	0·33	1·30	0·97	1·87	0·08
	Khasi and Jaintia Hills	Shillong	0·03	1·65	0·82	1·23	...	0·01	0·05	0·03	0·08	1·20	1·40
		Jawai	0·10	0·20	0·80	...	...	0·09	...	0·10	0·30	6·10	11·90
		Cherra Poonjee	2·14	6·88	2·54	...	0·23	0·22	1·12	0·90	1·10	8·13	12·05
	Naga Hills	Samagoodting	0·10	0·33	0·08	...	0·30	0·11	0·37	0·18	...	0·09	0·57
		Molongkong	1·20	0·82	...	0·26	0·23	...	1·12	0·83	0·86	08·8	1·39

Bengal and Assam in September 1878.—concluded.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	TOTAL.
0·08	0·60	...	...	...	..	...	...	...	...	1·15	0·19	0·59	0·02	...	3·78	0·17	...	...	24·58
0.36	0·89	0·17	...	...	...	...	1·65	...	...	...	0·15	0·30	0·40	...	0·40	0·70	0·60	...	13·58
0·18	0·58	...	...	...	...	...	0·09	...	...	1·31	0·04	0·10	0·10	...	0·42	0·04	...	...	12·56
0·23	0·63	...	...	...	...	0·12	...	...	0·19	2·01	0·18	0·08	...	...	0·57	0·08	0·01	0·12	14·14
0·55	1·10	...	...	...	...	...	...	..	...	2·07	5·89	5·65	0·01	...	...	...	2·08	...	28·42
0·20	0·58	...	...	...	...	...	...	...	...	2·00	4·50	10·50	0·08	...	...	...	...	...	29·16
0·63	0·08	0·29	...	0·45	0·23	0·28	0·07	0·09	0·94	1·03	9·33	7·29	...	0·31	2·06	0·48	0·10	0·57	39·86
0·65	1·17	...	...	...	...	...	...	...	...	0·85	2·00	0·45	...	...	0·06	...	0·30	...	9·87
0·14	1·54	...	...	...	...	...	...	...	...	3·73	3·57	1·46	0·60	...	0·02	0·81	0·69	...	18·07
1·10	0·28	...	...	...	...	...	...	...	2·06	1·45	1·88	...	0·08	...	1·32	0·39	...	0·35	13·36
0·15	1·92	...	...	...	...	...	...	...	...	1·59	1·69	0·57	...	...	...	1·65	...	...	12·14
1·02	1·92	...	...	...	...	...	...	0·26	1·40	1·72	1·35	...	...	...	0·88	...	...	...	16·55
0·43	1·26	...	...	...	...	...	0·23	...	...	2·51	1·88	1·43	...	0·29	...	0·71	...	0·06	14·76
0·07	0·89	...	...	...	...	...	2·06	...	...	0·03	0·22	0·40	0·58	1·27	...	0·08	...	...	13·71
0·90	1·60	0·10	...	...	...	...	...	...	...	0·10	0·13	...	...	...	...	0·20	...	...	12·87
0·16	1·52	...	...	...	0·12	...	...	...	...	...	0·25	0·15	...	...	...	0·05	...	...	9·62
0·19	1·32	0·11	...	...	...	...	...	...	...	0·91	0·63	0·04	...	0·78	...	...	...	...	14·64
0·12	0·70	0·47	...	...	...	...	...	...	...	0·11	0·28	...	...	0·11	...	...	2·20	...	19·79
0·10	2·15	...	...	...	...	...	...	...	...	2·06	0·50	2·25	0·52	0·35	0·26	0·30	...	...	18·95
0·15	0·11	...	...	...	...	...	0·41	...	0·01	...	0·50	0·01	1·39	0·15	...	...	...	0·15	8·72
1·69	0·05	0·06	...	...	...	...	...	0·07	0·06	0·18	0·28	0·43	0·61	0·20	0·25	0·78	0·20	...	11·36
3·40	4·20	1·60	0·10	...	0·10	0·80	...	0·10	0·20	5·10	9·80	9·10	0·60	...	...	...	...	...	54·69
5·47	4·53	1·00	...	0·21	...	0·60	...	...	...	9·86	12·42	5·90	0·30	...	...	0·78	0·30	...	76·68
0·37	3·28	0·16	0·03	0·71	0·13	...	...	0·03	...	1·85	0·70	0·35	0·73	0·05	0·05	0·93	...	...	11·50
0·67	0·91	0·01	...	...	...	...	...	...	1·80	0·37	0·70	0·52	0·01	0·08	0·15	0·02	...	...	11·83

II.—List of Cyclones on the West Coast of India and in the Arabian Sea up to the end of the year 1881, compiled by FRED. CHAMBERS, *Meteorological Reporter for Western India.*

The following list of cyclones has been drawn up by direction of Mr. H. F. Blanford, Meteorological Reporter to the Government of India. It is prepared on the same plan as the catalogue of cyclones in the Bay of Bengal,* published by that gentleman in Vol. XLVI, pp. 328 to 338 of the Journal of the Asiatic Society of Bengal, where Mr. Blanford describes his object to have been, to ascertain with greater accuracy than had previously been practicable, what is the distribution of cyclones at the different seasons of the year, and what parts of the area are most liable to storms in each season of the year.

The basis of the present catalogue has been the list of authorities quoted in Mr. Blanford's paper, together with some others, and the manuscript records of the observatories of Bombay, Poona, Belgaum, Deesa and Karachi, and of those more recently established throughout Western India. The authorities are enumerated below, along with the abbreviations employed for reference in the list.

B. I.—Buist's first catalogue. Transactions of the Bombay Geographical Society. Vol XII, Appendix A.

B. II.—Buist's second catalogue. Transactions of the Bombay Geographical Society. Vol. XV, p. 19.

C.—Capper's Winds and Monsoons.

H. I. D.—Horsburgh's Indian Directory.

J. A. S. B.—Journal of the Asiatic Society of Bengal.

P. S. H.—Piddington's Sailor's Horn-book.

I. G. I.—Imperial Gazetteer of India.

B. M. M. O.—Bombay Magnetical and Meteorological Observations.

MSS.—Manuscript records of Meteorological Observatories in Western India.

T. B. G. S.—Transactions of the Bombay Geographical Society.

M. M.—Meteorological Magazine.

A.—The Author (Mr. F. Chambers).

Z. O. G. M.—Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie.

M. M. R.—Mauritius Meteorological Results.

B. M. R.—Bengal Meteorological Reports.

In order to determine, with certainty, that an observed gale at any station forms part of a real cyclone and is not a mere local squall, it is necessary that observations of the direction of the wind at several other stations, not too far from the first one, should also be observed. In the absence of this additional information, and of any decided barometric indications, all that can be done is, to adopt certain more or less arbitrary conditions which, if satisfied, shall be taken to indicate the existence of a real cyclone. In the first place, then, there is reason to believe that the pure summer monsoon wind of Western India never reaches a velocity twice as great as its average July velocity; for this could not occur, unless the barometric gradients, while retaining the same direction, became about twice as great as the normal gradients of the month of July—a condition which has probably never been fulfilled. Now, the normal monsoon wind of the month of July has, at Bombay, a velocity of less than twenty miles per hour. It is,

therefore, highly probable that every long-continued wind which reaches a velocity of twice this amount, *i. e.*, forty miles per hour, is due to cyclonic motion of the atmosphere. No doubt, local squalls, exceeding forty miles per hour in velocity, frequently occur, but these are always of short duration. If, therefore, in the second place, we decide to exclude all storms which do not give rise to an average abnormal wind of twenty miles per hour, blowing for the whole of a day, it is pretty certain that these local squalls will all be excluded. It is true that the adoption of both these limiting conditions will, in the absence of other information, occasionally exclude real cyclonic storms, as, for example, storms Nos. 46 and 69 of the list, both of which would have been excluded, if the Bombay observations had alone been available; but such cases of exclusion will probably not be very numerous. In drawing up the list of storms, these limiting conditions have been used in cases where the pressure of the wind has been observed instead of the velocity; the corresponding limits have been taken at a pressure of 8 lbs. per square foot at any moment, and at an average abnormal pressure of 2 lbs. per square foot for the whole of a day.

Those cyclones that have, in all probability, passed across the Indian Peninsula from the Bay of Bengal to the Arabian Sea, are marked with an asterisk; some are marked not only with an asterisk but also with a note of interrogation, implying that, although there is some evidence of their having passed from E. to W., or of their having been immediately preceded by a cyclone in the Bay of Bengal, there is not sufficient proof to identify the storm on the west coast with a previous one in the Bay of Bengal.

List of Cyclones on the West Coast of India and in the Arabian Sea.

No.	Year.	Month.	Days.	Details of Storm.	Authority.
1	1648	May	27	A furious hurricane prevailed from Bombay northward, accompanied by an earthquake.	B. I.
2	1762	May	?	Hurricane off Goa	C. p. 63.
3	1779	April	About middle.	Hurricane near Anjengo. H. E. I. Company's *Cruiser* attempted to put to sea when too late, and was never afterwards seen.	C. p. 63.
4	1782	April	20—21	A very heavy storm from southward on most parts of the West Coast of India. H. M. S. *Cuddalore*, *Revenge*, and several other ships foundered with their crews. *Essex*, *Nancy*, and others dismasted. At Surat the *Fatty Bumbarack* and other ships were wrecked. In Gulf of Cambay, storm was accompanied by a dreadful inundation.	H. I. D. Vol. I, p. 493. Do. p. 444. B. I.
5	1782	May	20	Ships *Prudence* and *Union* driven from Calicut Road in a storm and wrecked.	H. I. D. Vol. I, p. 481?
6	?	June	?	Ship *Shah Byramgore* in a heavy gale was wrecked on rocks near Yersavah. Crew perished.	H. I. D. Vol. I, p. 427.
7	1783	November	3—7	Violent hurricane from Tellicherry northward to Bombay. Great loss of shipping and lives.	B. I.
8	1791	February	10—11	Strong gale from north off Choul for thirty hours. Reefed topsails.	H. I. D. Vol. I, p. 493.
9	1799	November	3—7	Frightful hurricane from Calicut northward. H. M. Ship *Resolution*, Ships *Hercules*, *Hunter* and about 100 small crafts wrecked in Bombay Harbour. About 400 lives lost. At Bombay the wind was from S. E. and for some time blew with hurricane force from eastward.	B. I. H. I. D. Vol. I, p. 491.
10*	1805	January	7	Hurricane at Trincomalee, on Coromandel coast, and across to Tellicherry on Malabar coast.	B. I.
11	1807	June	24	Furious hurricane off Mangalore	B. I.
12	1811	June	4—5	Cyclone in Lat. 16°N. Long. 70°E. H. C. S. *Essex* involved .	J. A. S. B. Vol. XVII, Pt. 1, p. 35.

List of Cyclones on the West Coast of India and in the Arabian Sea,—continued.

No.	Year.	Month.	Days.	Details of Storm.	Authority.
13	1819	September .	25	Hurricane in Cutch and Kattiwar. Lasted a day and two nights.	B. I.
14*	1820	May .	8	Hurricane to the southward of Bombay. Some loss of shipping. Came over from Madras.	B. I.
15	1827	December .	20	Hurricane at Bombay?	B. I.
16	1836	June .	8—9	Cyclone in Lat. 23° N., Long. 63° to 65° E. H. C. Cruiser *Ternate* involved.	P. S. H., p. 52.
17	1837	June .	15	Tremendous hurricane swept over Bombay. Immense destruction of property and loss of shipping in the harbour, estimated at upwards of £90,000. Four hundred houses destroyed.	B. I.
18*?	1840	May .	?	Hurricane off Madras and Southern Coast	B. I.
19*	1842	October . November .	22 to 2	Cyclone originated in the Bay of Bengal, passed over Madras and Southern India, and across the Arabian Sea as far as Aden.	J. A. S. B. Vol. XII, Pt. I, pp. 339 to 399.
20*	1845	November . December .	29 to 5	Cyclone in Bay of Bengal crossed Ceylon, Cape Comorin, the Laccadives and the Arabian Sea to Lat. 13° N., Long. 60° E.	J. A. S. B. Vol. XIV, Pt. II. pp. 878 to 916.
21*	1846	November .	25—26	Violent hurricane at Madras, and across to Mangalore and Cochin.	B. I.
22	1847	April .	16—19	Terrific hurricane from the Equator along the Malabar coast northward to Sind. H. M. *Cleopatra* lost with 150 lives.	B. I. J. A. S. B. Vol. XVII, Pt. I, pp. 27 to 56.
				Laccadive Islands submerged	I. G. I. Vol. VI, p. 5.
23	1848	April .	23	Violent hurricane off Ceylon. H. M.'s Brig *Jumna* nearly lost.	B. I.
24	1848	June .	18—19	Gale at Bombay from west. Maximum pressure of the wind 9 lb per square foot, accompanied by a slight barometric depression.	B. M. M. O. 1848.
25*	1851	May .	1—6	A furious hurricane raged off the east of Ceylon. Passed over Madras and swept across peninsula, sending up a tremendous swell towards Sind.	B. I.
26	1851	May .	28	Gale at Bombay from south-south-east. Maximum pressure of the wind 10 lb per square foot. No depression of barometer.	B. M. M. O. 1851.
27*?	1853	March .	26—28	Furious hurricane all over Southern India	B. I.
28	1854	October .	6	Hurricane south of Ceylon	B. I.
29	1854	November .	1—2	Hurricane at Bombay from east-south-east. Maximum pressure of wind 35 lbs per square foot. Wind veered from east-south-east to north. Barometer fell 6-10ths of an inch. About 1,000 lives and £500,000 worth of property lost in four hours.	B. I. B. M. M. O. 1854.
30	1855	October .	29—30	Cyclone in Arabian Sea, between Lat. 14° and 16° N., and Long. 55° to 58° E. Encountered by Ships *Bangalore* and *Chevalier*. Centre moved from east to west at from 7 to 10 miles per hour.	P. S. H. p. 52.
31	1856	April .	18—20	Well-defined cyclone in Arabian Sea between Cooria Mooria Bay and the Gulf of Aden. S. S. *Queen* involved.	B. II.
32	1856	May . June .	30 to 1	Gale from south at Bombay. Maximum pressure of the wind 14·5 lb per square foot. Wind veered from south-east to south-by-west, accompanied by a barometric depression. Gale also felt at Poona, where the maximum pressure of the wind was 13·25 lb per square foot, and where the vane veered from south-east to west.	B. M. M. O. 1856. MSS.
33	1857	November .	20	Hurricane on the west coast of Ceylon	B. II.
34*	1858	May .	15—20	Cyclone in Bay of Bengal. Crossed to Malabar coast . .	B. II.
35*	1859	April .	21—28	Cyclone off Negapatam. Crossed the peninsula to Tellichery. *Colorado* wrecked at Port Pedro.	B. II.
36	1859	June .	2—3	Well-defined cyclone in Arabian Sea. Ship *Typhoon* in Lat. 15° 30′ N., Long. 66° E., experienced a terrific gale from south-west. At Bombay, a gale from south blew with a maximum pressure of 10·5 lb per square foot.	B. II. B. M. M. O. 1859.

List of Cyclones on the West Coast of India and in the Arabian Sea,—continued.

No.	Year.	Month.	Days.	Details of Storm.	Authority.
37	1862	June	14	Gale at Bombay from south-south-west. Maximum pressure of the wind 10·75 lb per square foot.	B. M. M. O. 1862.
38	1862	November	19—23	Cyclone off West Coast of India. Ships *Jamsetjee Jeejeeboy* and *Cecrops* involved. The latter reported a fearful hurricane and a minimum barometer reading of 28·10, the mercury having fallen from 29·90, the reading before the storm.	T. B. G. S. Vol. XVI, pp. 127 to 137.
39	1864	April	29	Cyclone off Ras Ulloolah in Lat. 13° N., Long. 51° E. Encountered by S. S. *Candia*, which was dismasted and had its boats blown away. Storm lasted from 9 A.M. to 6 P.M. Wind veered from north-north-east to south-east and blew with terrific force at 1 P.M. Barometer lowest at noon, when it read 29·10.	M. M. Vol. I, p. 61.
40	1866	June	14	Whole gale at Bombay from south-south-east. Maximum velocity 70 miles per hour. Direction of wind south-west at Belgaum and Poona; calm at Deesa and Kurrachee. Cyclonic depression of barometer moved from Belgaum to Kurrachee in three days, during which wind veered from south-east to south-west at Bombay, and from south-south-east to west at Deesa.	MSS.
41	1867	?	?	Cyclone passed over Minicoi Island. One-sixth of male population perished.	I. G. I. Vol. VI, p. 6.
42	1868	February	23	Gale at Deesa from north-west. Maximum pressure 12·25 lb per square foot. Cyclonic depression of barometer moved from north-west to south-east.	MSS.
43	1868	June	8—10	Gale at Bombay from south-east and south. Maximum velocity 46 miles per hour. Cyclonic depression of barometer at Belgaum, Poona, Bombay, Deesa and Kurrachee. Wind veered at each station from north-eastward to south-westward.	MSS.
44	1868	August	9—11	Gale from south-west at Bombay with 9·8 inches of rain on 9th. Maximum velocity of wind 50 miles per hour. Cyclonic depression of barometer at Deesa, lowest on 11th. Fourteen inches of rain fell at this station on the 10th and 11th, and 18 inches were gauged at Ahmedabad on the 11th, all of which fell in the preceding 24 hours. At Deesa the wind changed from north-east to calm and to west. At Kurrachee the wind on the 11th was from south-west, but very weak.	MSS.
45	1869	June	4—6	Gale at Bombay from south-east and south. Maximum velocity 59 miles per hour. Wind veered from south-east to west-south-west. *Bucentaur* wrecked on Prongs.	MSS.
46	1871	January	15	Cyclone off Ratnagiri. S. S. *General Outram* foundered. Maximum velocity of wind at Bombay 48 miles per hour, from east-south-east. Cyclonic depression of barometer at Bombay, Poona, and Belgaum. Centre passed inland between Bombay and Ratnagiri in a north-easterly direction. Gale from north-east at Deesa on 16th. Maximum pressure 9 lb per square foot.	MSS. A.
47	1871	May	5—7	Cyclone in the Arabian Sea in Lat. 16° N., Long. 59° E. Encountered by S. S. *Apis*. Barometer fell 1·2 inch.	Z. O. G. M. Vol. VI, p. 285.
48	1871	June	29—30	Strong gales from south by west in Arabian Sea between Lat. 6° to 10° N., and Long. 50° to 53° E. Encountered by *Leonidas*.	M. M. R., 1871, p. 12.
49	1871	August	3—4	Gale at Deesa. Maximum pressure of wind 12·25 lb. per square foot. Houses and trees blown down. 15·5 inches of rain fell. Cyclonic depression of barometer.	MSS.
50	1871	November	12—13	Gale at Bombay from south-south-east. Maximum velocity of wind 48 miles per hour. Cyclonic depression of barometer at Bombay and Poona on 12th and at Deesa on 13th.	MSS.
51	1872	January	28	Gale at Kurrachee. Maximum pressure of wind 12·2 lb. per square foot.	MSS.
52*	1872	April May	29 to 3	Cyclone at Madras. Passed over peninsula to Calicut and affected barometers at Belgaum and Bombay.	B. M. R. 1872. MSS.
53	1872	June	16—17	Gale at Bombay from south-east on 16th. Maximum velocity 46 miles per hour. Gale at Deesa from south-east on the 17th. Maximum pressure 9 lbs. per square foot. Winds cyclonic, being west at Belgaum and Poona, south-east at Bombay and Deesa, and calm at Kurrachee.	MSS

List of Cyclones on the West Coast of India and in the Arabian Sea,—continued.

No.	Year.	Month.	Days.	Details of Storm.	Authority.
54* ?	1872	September .	14—16	Gale at Deesa. Maximum pressure 20·25 lb per square foot. Cyclonic depression of barometer. Wind veered from north-north-west to south-east, and at Kurrachee from north to south-west. At Bombay, strong wind on 17th *backed* from north-west to south-east. Barometric depression later at Kurrachee than at Deesa. Centre of disturbance appears to have passed from east to west between Bombay and Deesa.	MSS.
55	1873	January .	17	Gale at Deesa from south. Maximum pressure 9 lb per square foot. Strong wind at Kurrachee. Maximum velocity 38 miles per hour. Cyclonic depression of barometer at Deesa and Kurrachee.	MSS.
56	1873	June .	1	Gale at Bombay from south-east. Maximum velocity 43 miles per hour. No decided barometric depression.	MSS.
57	1874	February .	10	Gale at Kurrachee from west. Maximum velocity 41 miles per hour. Strong wind at Deesa, also from west. Cyclonic depression of barometer at Kurrachee and Deesa.	MSS.
58	1874	March .	22	Gale at Kurrachee from west. Maximum velocity 43 miles per hour.	MSS.
59	1874	June .	6—10	Gale at Bombay from south-east. Maximum velocity 47 miles per hour. Slight rise of barometer at all five observatories. Winds cyclonic, being from west to south-west at Belgaum and Poona, south to south-east at Bombay and Deesa, and east at Kurrachee.	MSS.
60* ?	1874	June .	17—19	Gale at Bombay from west-south-west. Maximum velocity 47 miles per hour. Strong winds at Belgaum, Deesa and Kurrachee, where maximum pressures of 8·5 lb, 9lb, and 26 lb per square foot respectively were recorded. Winds cyclonic, being from west and south-west at Belgaum, Poona, and Bombay, south-east at Deesa, and from west, but very weak, on 17th at Kurrachee. No decided barometric depression.	MSS.
61	1875	June .	9—10	Gale at Bombay from south-east. Maximum velocity 45 miles per hour. Wind veered from north-east to south-east. No cyclonic depression of barometer.	MSS.
62	1875	July .	19	Gale at Kurrachee from south-west. Maximum velocity 45 miles per hour. Strong wind at Deesa from south-south-west on 18th. Maximum pressure 6·25 lb per square foot, accompanied by a cyclonic depression of the barometer, and 7·25 inches of rain.	MSS.
63	1876	April .	12	Gale at Bombay from south. Maximum velocity 42 miles per hour. Cyclonic depression of barometer at Kurrachee and Deesa.	MSS.
64	1877	October .	2—7	Gale at Bombay from south-east. Maximum velocity 42 miles per hour. Cyclonic depression of barometer at Rajkot and Surat. Centre appears to have passed inland from Rajkot to Neemuch in two days.	MSS.
65	1878	June .	19	Gale at Bombay from south-east. Maximum velocity 46 miles per hour. No barometric depression.	MSS.
66	1878	September .	7—9	Gale at Bombay from south-east. Maximum velocity 42 miles per hour. Low barometer at Bombay and Surat.	MSS.
67*	1879	May .	21—26	Southerly gale along the west coast of India from Karwar to Surat. Maximum velocity of the wind at Bombay 56 miles per hour. Great destruction of native crafts. Cyclonic depression of barometer passed along the coast from Karwar to Bhuj, having come across the peninsula from Madras to Karwar.	MSS.
68*	1880	November .	21—23	Cyclone crossed the peninsula from Negapatam to Calicut and was felt in the Arabian Sea in Lat. 17° N., Long. 66° E., by S. S. *Albula*, which encountered a fresh north-east gale, veering to south-east.	MSS. A.
69	1881	May . June .	27 to 3	Violent cyclone crossed the Arabian Sea from east to west. Lowest barometer reading 27·3. Wind at Bombay from south-south-east with a maximum velocity of 36 miles per hour. No cyclonic depression of barometer on west coast of India.	A.
70* ?	1881	July .	11—12	Cyclone in Kutch and Kattiwar. Cyclonic depression of barometer at Bhuj and Rajkot. At Jamnagar 28½ inches of rain are said to have fallen during the storm.	MSS. A.

By counting up the number of storms in each month of the year the relative frequency of storms in the different months comes out as follows:—

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
4	3	2	9	13	20	2	2	3	4	10	2

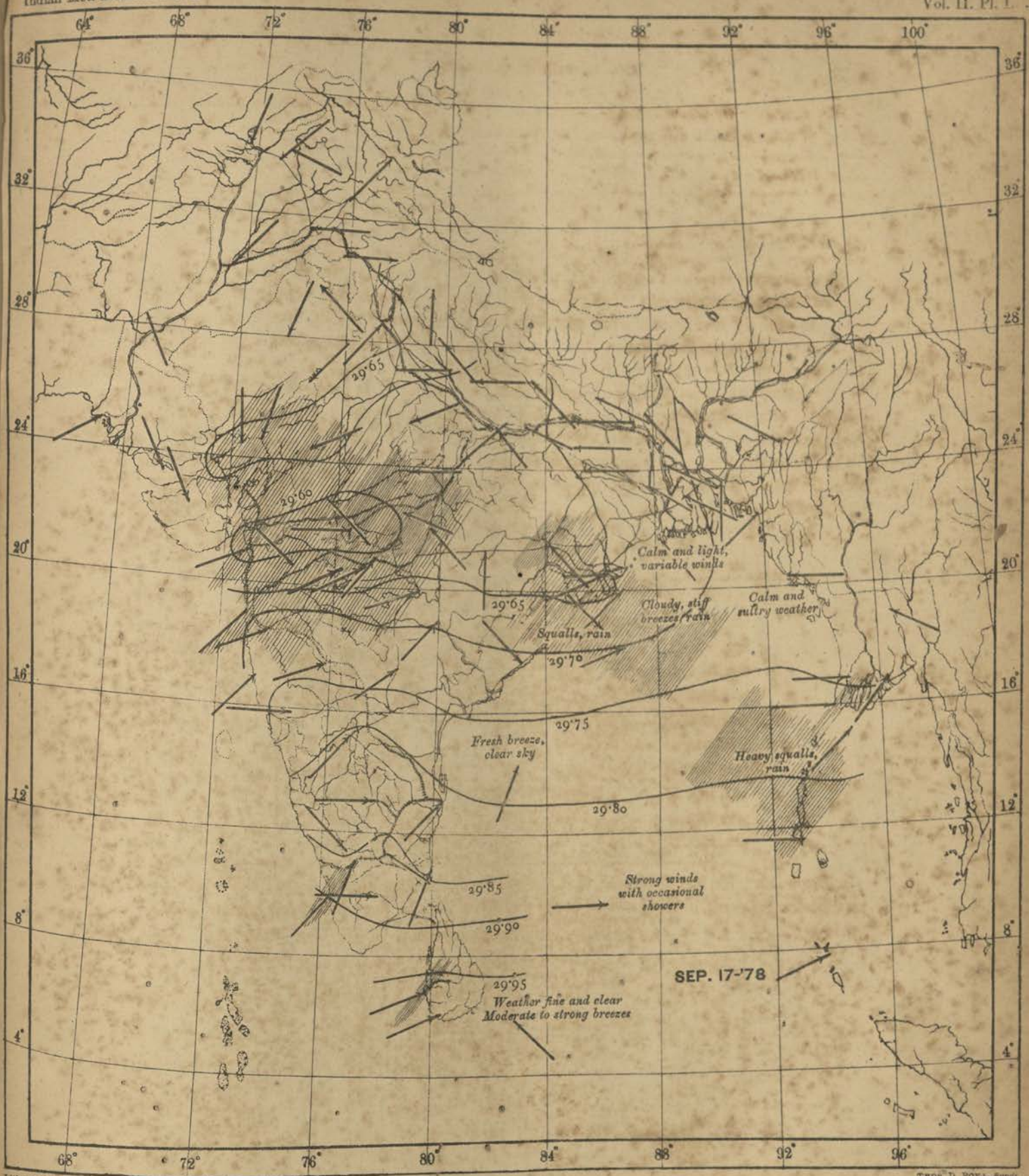
Storms are therefore far more frequent in June than in any other month of the year, and May, November and April follow each other in order of frequency. There is no month entirely free from storms, and it is interesting to notice that cyclones appear to be somewhat more frequent in January and February[1], the two coldest months of the year, than in July and August, the two wettest months.

By counting up the number of storms that have occurred in each year of the Sun-spot Cycle of about eleven years, and classing together those of every eleventh year, we obtain the results contained in the second column of the following table. The numbers in the third column are the corresponding sun-spot numbers according to Wolf, and are taken from Dr. W. W. Hunter's paper on "The Cycle of Drought and Famine in Southern India."

Years.	Number of Storms.	Sun-spot Number.
1871, 1860, &c.	8	72·45
1872, 1861, „	5	57·25
1873, 1862, „	8	50·32
1874, 1863, „	5	40·87
1875, 1864, „	6	26·22
1876, 1865, „	4	10·92
1877, 1866, „	4	7·57
1878, 1867, „	7	12·47
1879, 1868, „	7	26·90
1880, 1869, „	5	52·88
1881, 1870, „	8	74·44

From this table it will be seen that the storms of the Arabian Sea are, on the whole, much more frequent in the years of many sun-spots than in the years of few spots.

[1] But see the next following Memoir.—H. F. B.



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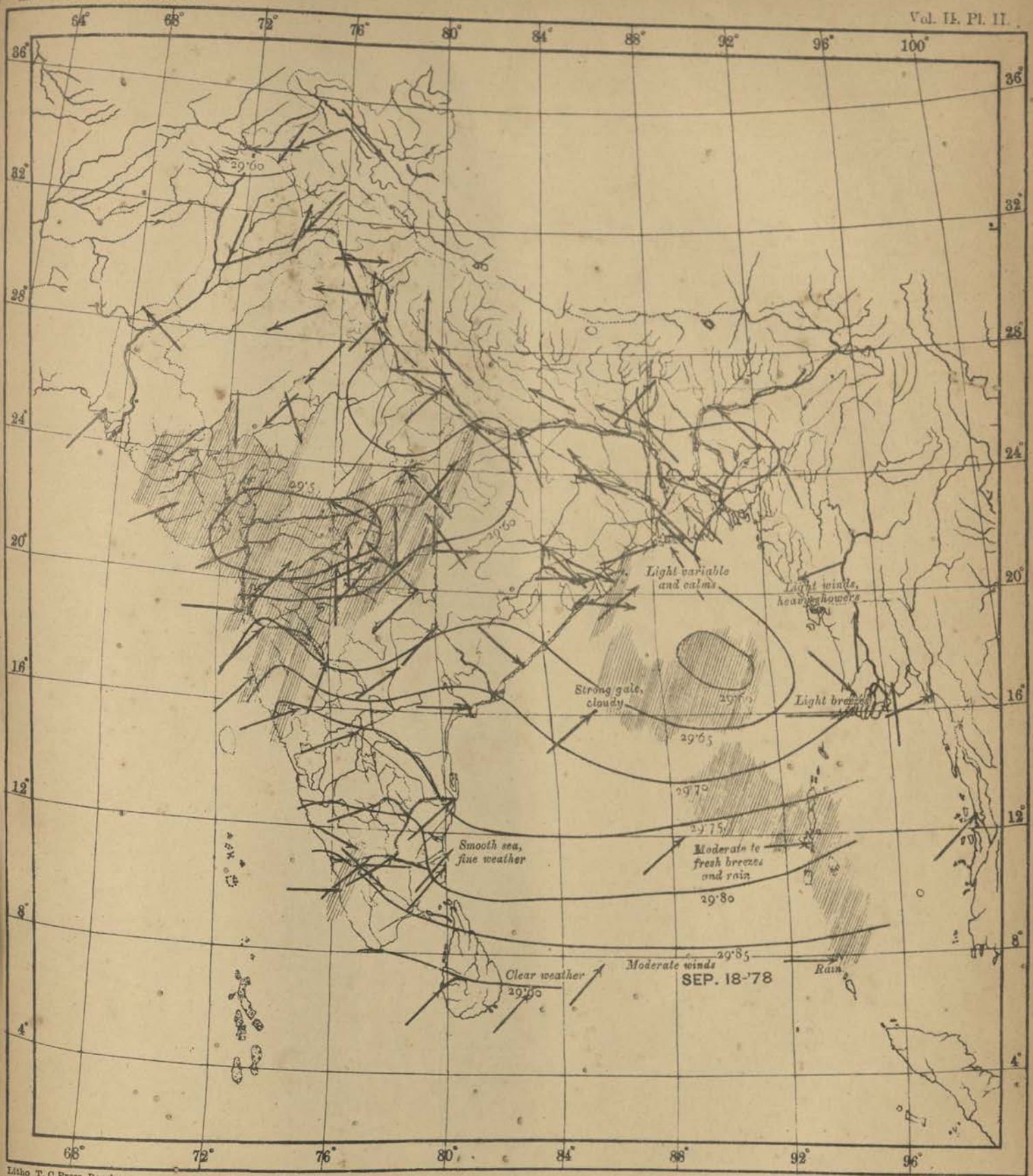

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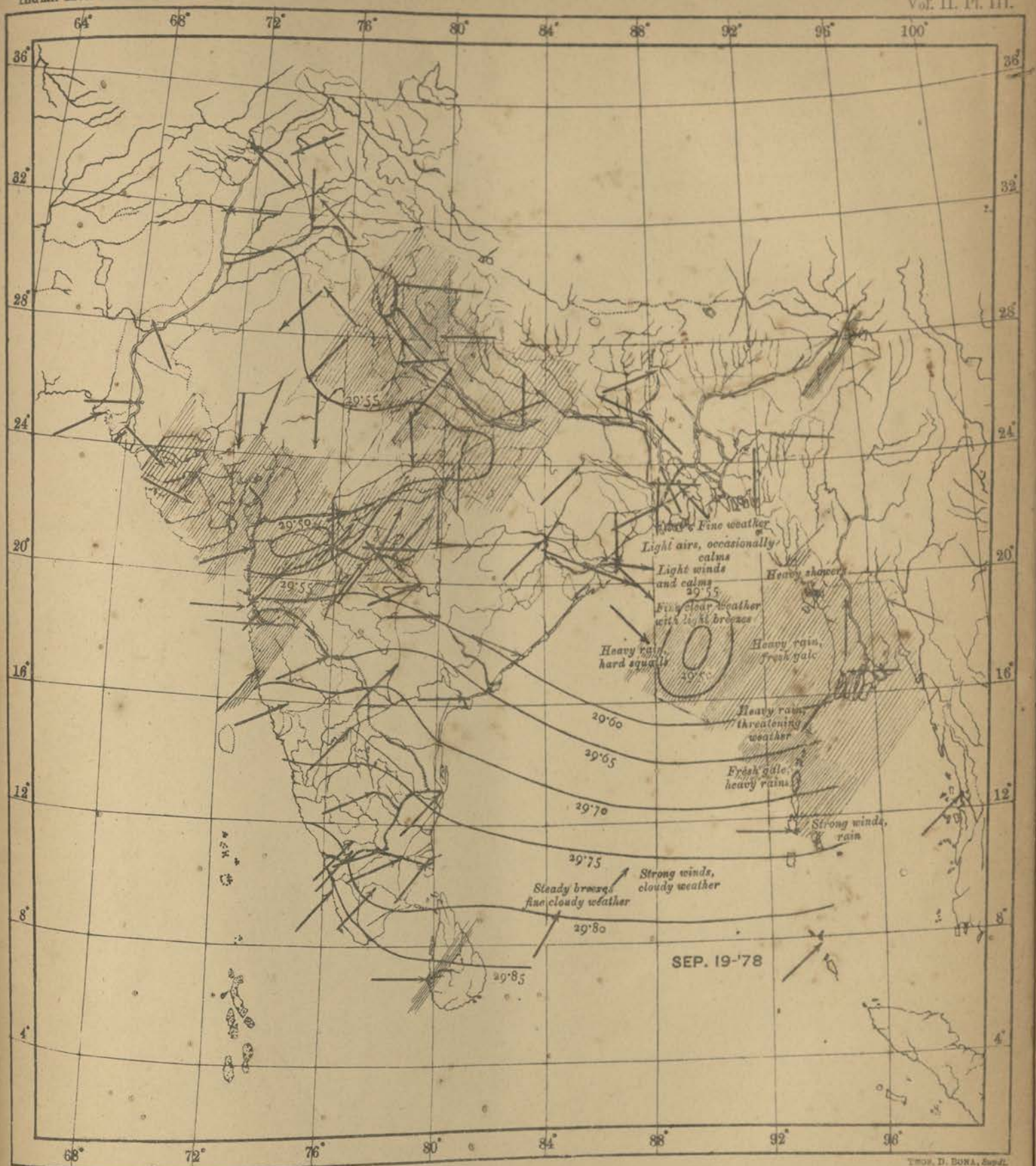

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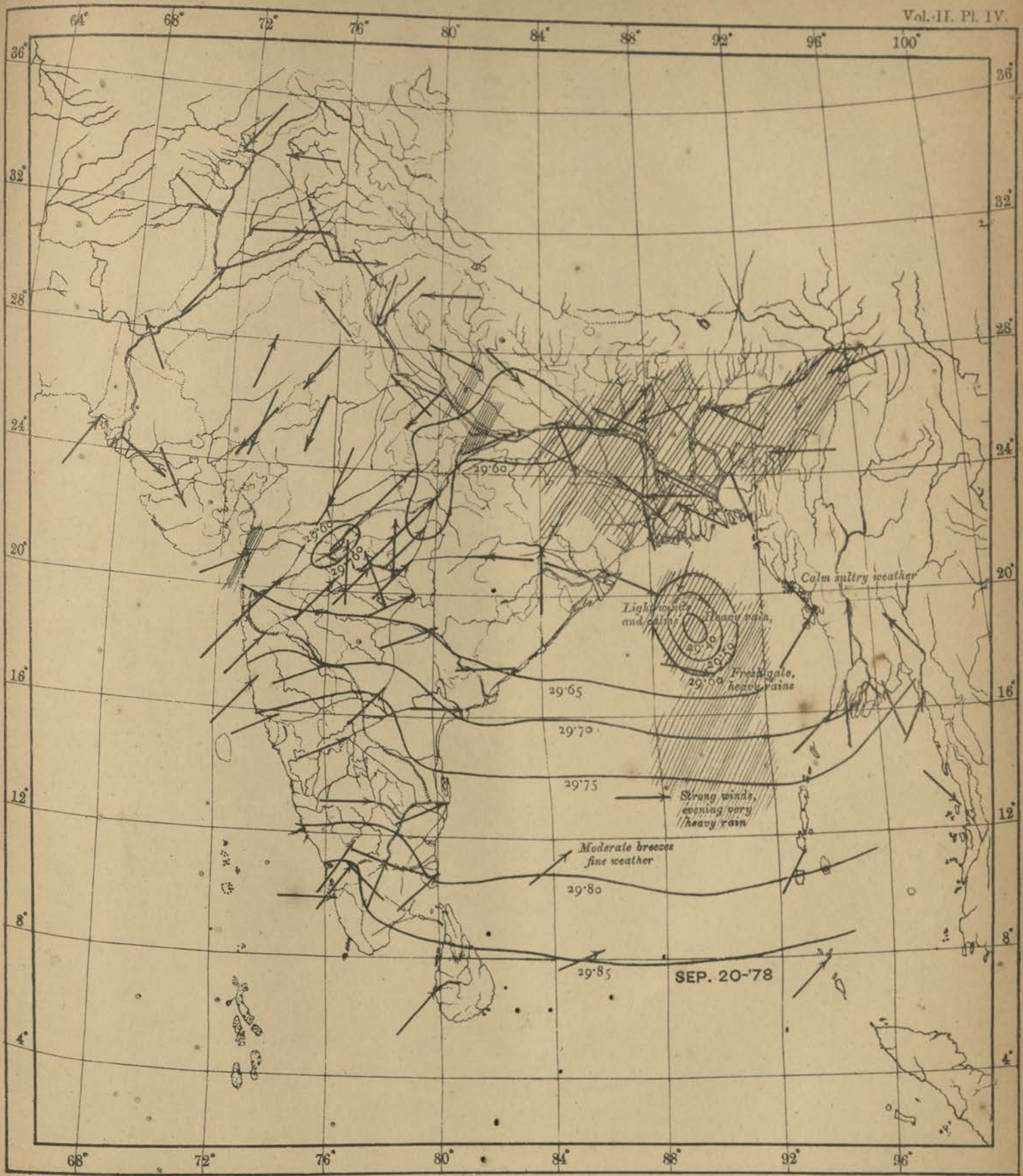

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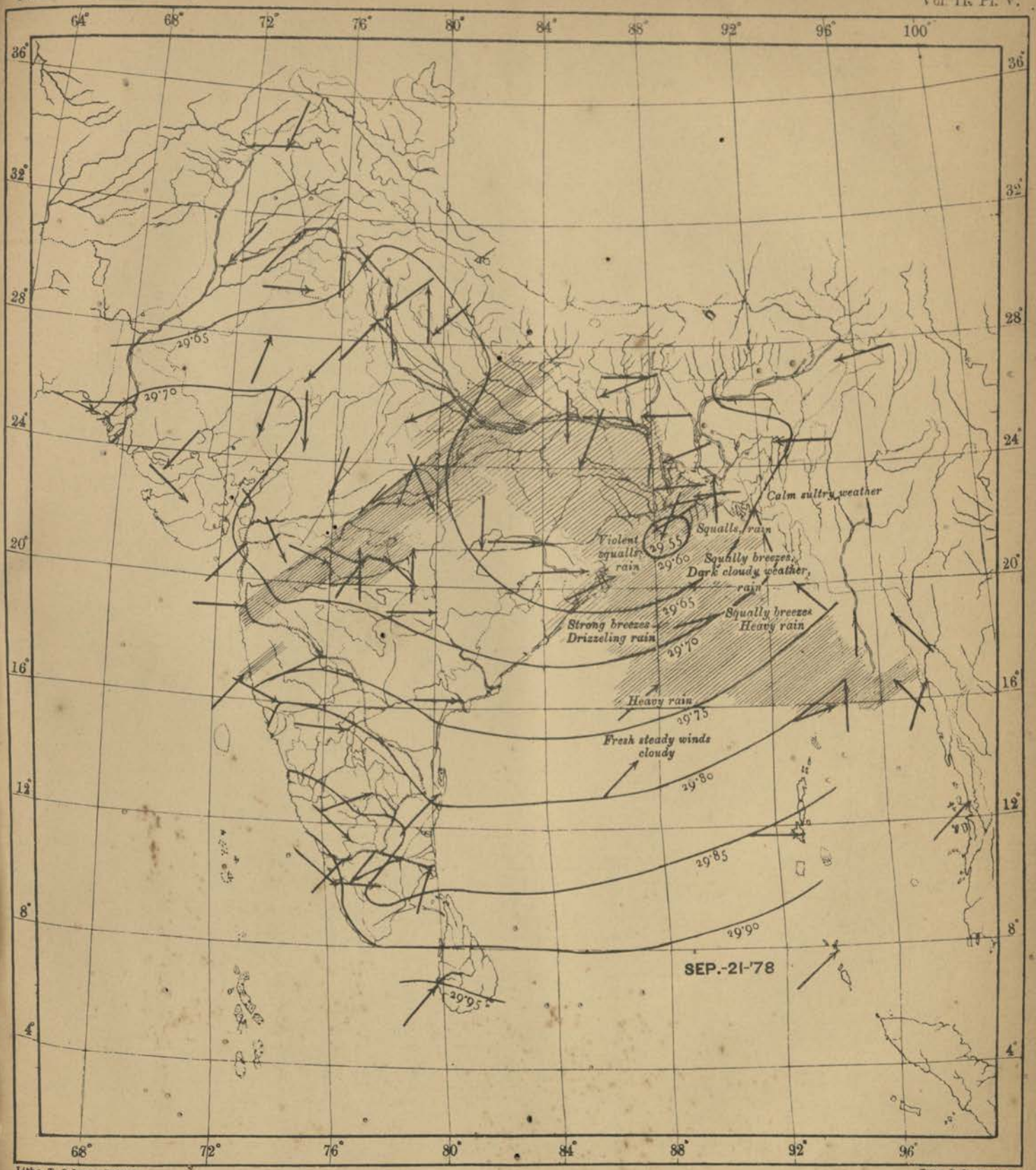

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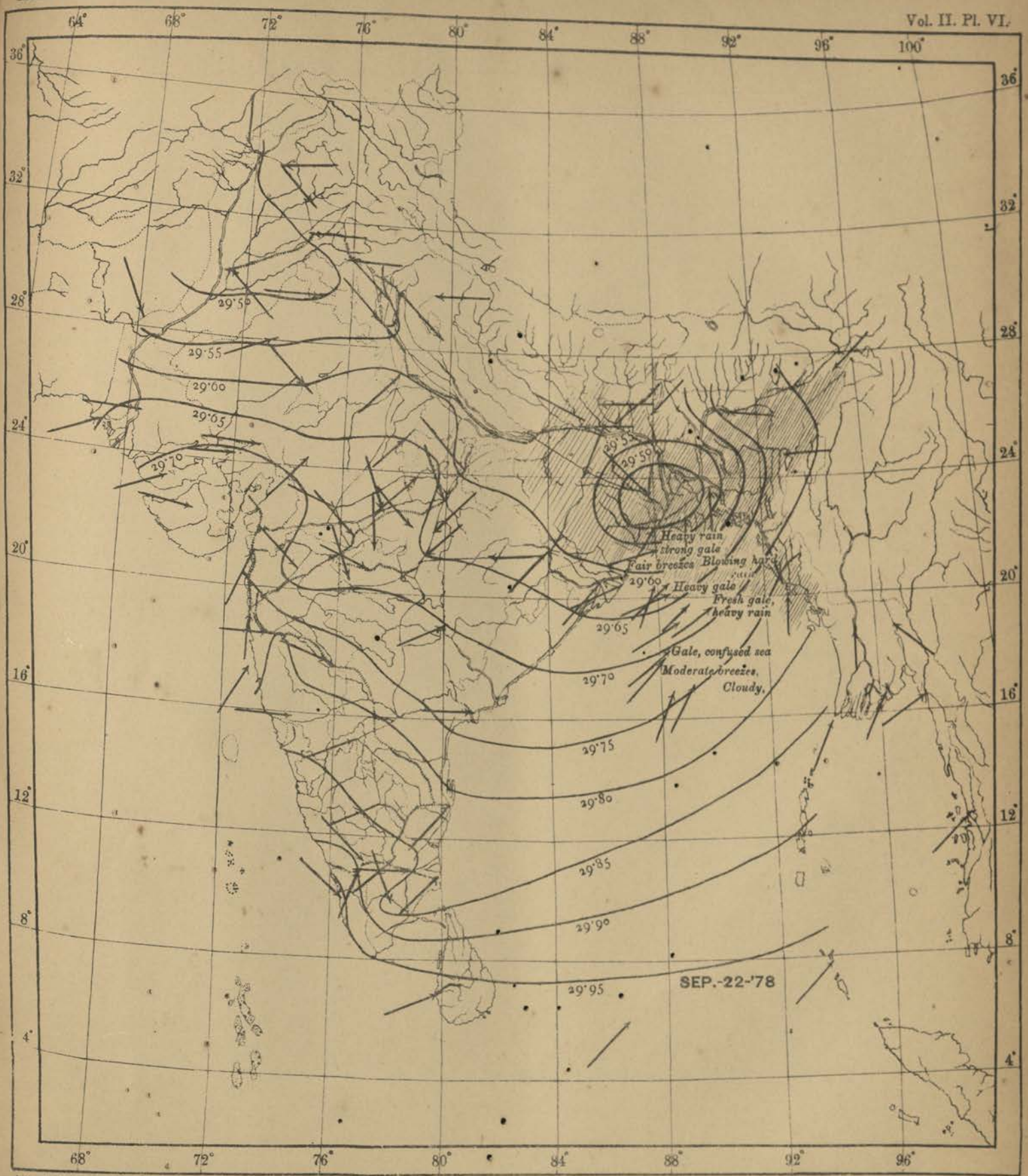

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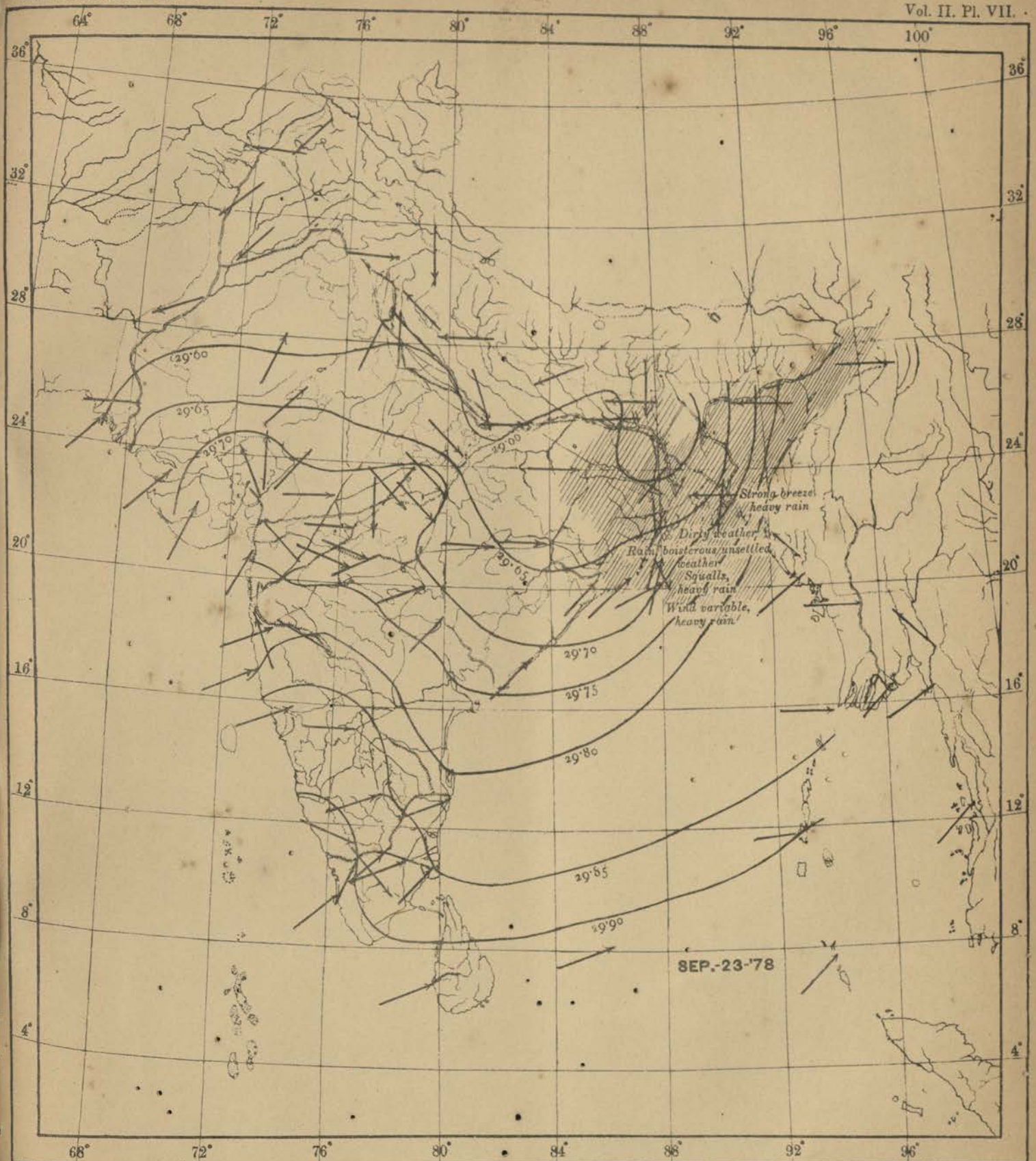

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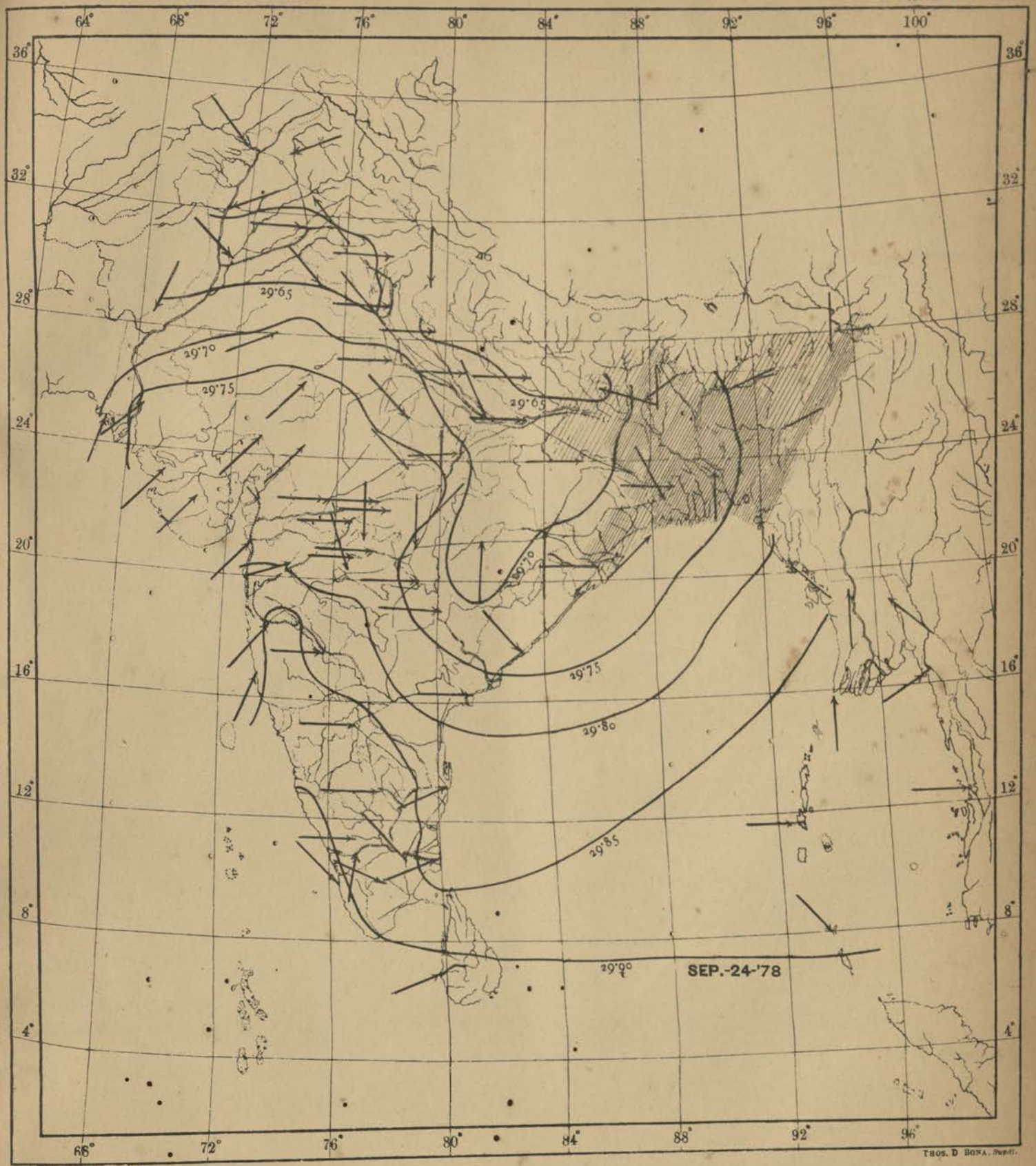

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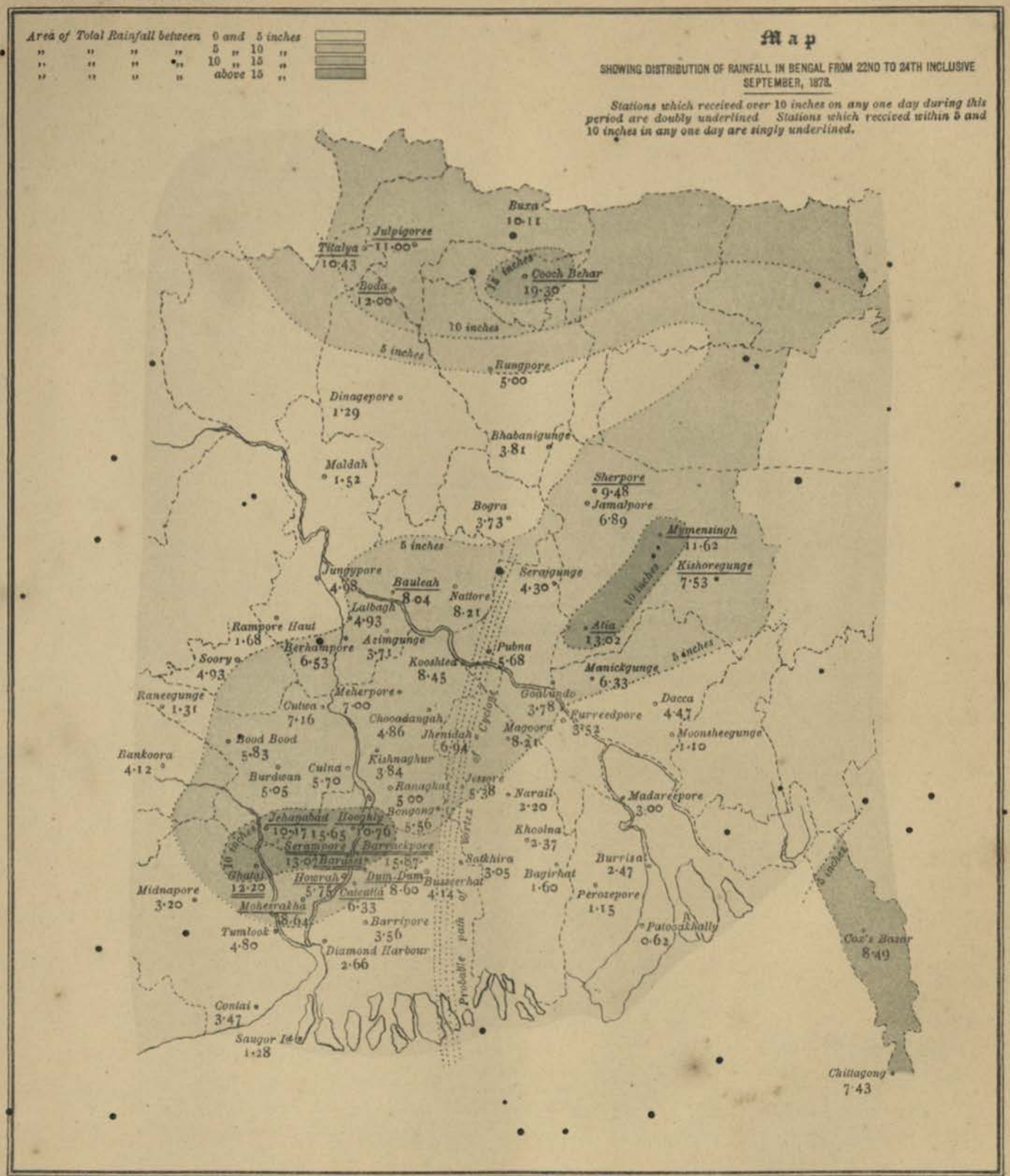

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STATION HAZARIBAGH.

	PAGE 112, TABLE I.		PAGE 121, TABLE III—C.		PAGE 121, TABLE III—D.	
	10 hours.	10 hours.				
	For	Read	For	Read	For	Read
January	+ 1·5	+ 4·9	— ·01	— ·06	0	— ·03
February	+ 1·6	+ 4·2	0	— ·06	0	— ·03
March	+ 3·0	+ 5·5	0	— ·03	+ ·01	— ·01
April	+ 2·5	+ 5·3	0	— ·03	+ ·01	— ·02
May	+ 2·0	+ 4·8	+ ·02	— ·02	+ ·03	0
June	+ 1·3	+ 3·5	+ ·04	— ·01	+ ·02	— ·01
July	+ 0·6	+ 1·9	+ ·05	+ ·01	+ ·02	— 01
August	+ 1·0	+ 1·9	+ ·05	+ ·02	0	0
September	+ 1·3	+ 2·8	0	— ·04	+ ·02	— ·01
October	+ 2·9	+ 4·7	— ·02	— ·06	0	— ·03
November	+ 3·3	+ 5·3	— ·02	— ·05	0	— ·03
December	+ 2·0	+ 5·0	0	— ·05	0	— ·03
Year	+ 1·9	+ 4·1	...	...	...	...

III.—Note on the foregoing List of Cyclones, and on the Gujarat land-cyclone of July 11th-13th, 1881, by HENRY F. BLANFORD, F.R.S., *Meteorological Reporter to the Government of India.*

The foregoing list of storms, that have been felt on the west coast of India, appears, in some respects, to be more comprehensive than that to which Mr. Chambers refers at his model, *viz.*, my own list of cyclonic storms in the Bay of Bengal, published in Volume XLVI of the Journal of the Asiatic Society of Bengal, (for 1877); and as the two lists are likely to be compared, with a view to elucidating points of resemblance or difference between the two regions respectively dealt with, it seems desirable that I should point out wherein they differ in character. I wish, also, to add some details respecting the last storm in Mr. Chambers' list, which, in certain respects, is unique in my experience of cyclonic storms, and which is of great importance to the study of the genesis of cyclones, having been formed over a land area surrounded by observatories. The list contains, however, others which, as I shall presently point out, were very probably of the same character.

The object with which my own list of recorded cyclones in the Bay of Bengal was drawn up, was stated to be that of "ascertaining with greater accuracy than had previously been practicable, what is the distribution of cyclones at the different seasons of the year; and also what parts of the Bay are most liable to storms in each season of the year." The list, therefore, included only cyclonic storms which had raged in the Bay of Bengal; or, if recorded only at coast stations, were of such character, as to admit of little reasonable doubt that they had been generated over the Bay: and such land-formed storms as the nor-westers of the spring and summer months, notwithstanding that the wind pressure in such storms frequently attains to cyclonic strength, (pressures of 50 lbs. to the square foot having been recorded in these storms, more than once at Calcutta), were rigorously excluded.

Mr. Chambers' object and rule of selection have been somewhat different. In addition to storms that have been experienced on the Arabian Sea, he desired to obtain a record of those which have been felt on the west coast of India, and which appear to have been cyclonic in character, without regard to the place of their origin; and he has thus included some, respecting which, there can be little or no doubt that they were formed over the land. The most recent and conspicuous example of this latter class is that of which I shall presently give a more detailed account, *viz.*, that of July 1881. But there are others probably of this character, and it is important to distinguish these, because, in some cases, they occur at a time of year, when, I have reason to believe that cyclones are practically unknown on the Arabian Sea, and it is obvious that, in working the storm-warning system, the question of the place of origin and the path followed by storms are points of primary importance. In dealing with storms, the only record of which is that afforded by the land observatories, a test may

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be applied to distinguish land-formed storms from those which approach from the sea, (that is, from the south-west or south in the case of the Bombay coasts), *viz.*, the direction of the wind at the beginning of the storm. A consideration of the well-known law of spiral winds in cyclonic storms will indicate, that, in storms of the latter class, the wind will probably begin from some quarter between north-east and south-east on the coast of the peninsula, between north and east on that of Sind, Cutch and Gujarat; from which it will veer or back, accordingly as the path of the storm is to north-west or south-east of the observatory. Now, applying this test to the storms recorded by Mr. Chambers, the following are almost certainly to be excluded from the list of sea-formed cyclones:—

No. 8. *February 10th and 11th, 1791.*—Strong gale from north off Choul for thirty hours.

„ 42. „ *23rd, 1868.*—Gale at Deesa from north-west. Maximum pressure 12·25 lbs. per square foot. Cyclonic depression of barometer moved from north-west to south-east.

„ 55. *January 17th, 1873.*—Gale at Deesa from south. Maximum pressure 9 lbs. per square foot. Strong wind at Kurrachee. Maximum velocity 38 miles per hour. Cyclonic depression of barometer at Deesa and Kurrachee.

„ 57. *February 10th, 1874.*—Gale at Kurrachee from west. Maximum velocity 41 miles per hour. Strong wind at Deesa, also from west. Cyclonic depression of barometer also at Kurrachee and Deesa.

No. 58. *March 22nd, 1874.*—Gale at Kurrachee from west. Maximum velocity 43 miles per hour.

„ 62. *July 19th, 1875.*—Gale at Kurrachee from south-west. Maximum velocity 45 miles per hour. Strong wind at Deesa from south-south-west. On 18th maximum pressure 6·25 lbs. per square foot, accompanied by a cyclonic depression of the barometer and 7·25 inches of rain.

„ 70. *July 11th—12th, 1881.*—Cyclone in Cutch and Kathiáwar. Cyclonic depression of barometer at Bhuj and Rajkot. At Jamnagar 28½ inches of rain are said to have fallen during the storm.

This last is the storm, the history of which I shall presently give, and which may probably stand as a type of many other storms in the list. And the following, though their exclusion is less certain, seem to me of very doubtful validity as sea-formed cyclones.—

No. 24. *June 18th—19th, 1848.*—Gale at Bombay from west. Maximum pressure of the wind 9 lbs per square foot, accompanied by a slight barometric depression.

„ 26. *May 28th, 1851.*—Gale at Bombay from south-south-east. Maximum pressure of the wind 10 lbs. per square foot. No depression of barometer.

„ 37. *June 14th, 1862.*—Gale at Bombay from south-south-west. Maximum pressure of the wind 10·75 lbs. per square foot.

„ 49. *August 3rd—4th, 1871.*—Gale at Deesa. Maximum pressure of wind 12·25 lbs. per square foot. Houses and trees blown down. 15·5 inches of rain fell. Cyclonic depression of barometer.

„ 51. *January 28th, 1872.*—Gale at Kurrachee. Maximum pressure of wind 12·2 lbs. per square foot.

„ 60. *June 17th—19th, 1874.*—Gale at Bombay from south-south-west. Maximum velocity 47 miles per hour. Strong winds at Belgaum, Deesa, and Kurrachee, where maximum pressures of 8·5 lbs., 9 lbs. and 26 lbs. per square foot respectively were recorded. Winds, cyclonic, being from west and south-west at Belgaum, Poona, and Bombay, south-east at Deesa and from west but very weak on 17th at Kurrachee. No decided barometric depression.

Now, of the storms, which, judged by the test of wind direction, should, I consider, certainly be excluded from the list of those generated over the Arabian Sea, one occurred in January, three in February, one in March and two in July. Five of these occurred at the season, when cyclonic storms are least frequent (in February unknown) in the Bay of Bengal, and when we may reasonably expect them to be equally rare in the Arabian Sea. All but the first (that of February 1791), are unquestionably instances of storms formed in the low-lying plain that extends between the Aravali Chain and the mountains forming the western frontier, the plain of Western Rajputana, Northern Gujarat and Sind. The other two are the two July storms of the list, and were, in the one case certainly, in the other probably, formed in the same region.

Of the six storms in the doubtful list, one is a January storm, respecting which, no other information is given, than that the force of the wind attained to a pressure of 12·2 lbs.; a pressure far surpassed by many an ordinary nor-wester squall. But as it may be inferred from Mr. Chambers' introductory remarks, that the strong wind was not merely temporary, but lasted for some 24 hours, it seems probable that this storm was of the same class as the January and February storms of the first list of exclusions. The others occurred, one in May, three in June, and one in August. Four of these may have been the result of local eddies, accompanying the first burst of the monsoon, such as frequently occur both at this period, and also during the monsoon months, on the coast of Orissa and the Sunderbuns. And the August storm, No. 49, recorded at Deesa, was probably of the same type as the two July storms of the former list.

Excluding these storms, Mr. Chambers' list, classified according to the months, will be as follows:—

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
2	0	1	9	12	17	0	1	3	4	10	2

which accords much more nearly with the list of Bay of Bengal storms, given in the *Vade Mecum*, than the more comprehensive summary given by Mr. Chambers. The Bay of Bengal list is as follows:—

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
2	0	2	9	21	10	3	4	6	31	18	9

The two lists accord then, in the fact that there are two annual epochs of maximum frequency, *viz.*, May and June, and October and November, an absolute freedom from cyclones in February, and a secondary period of minimum frequency in July and August. But whereas, in the Bay of Bengal, the close of the summer monsoon is the epoch of the absolute and a very preponderant maximum, on the Bombay coast, it is the beginning of the monsoon which enjoys the supremacy of storm production. At both epochs, too, the maximum falls a month later on the Bombay than on the Bengal side.

It is very possible that, among the storms in Mr. Chambers' list, which I have provisionally admitted as Arabian-Sea cyclones, a few might prove inadmissible, were more detailed information forthcoming; but it is unlikely that their exclusion would greatly alter the general features of the result.

In the category of land-formed storms, I do not include that important class of cyclonic storms, which, being originally formed over the Bay of Bengal, travel on a west or north-west course to the Madras or Coromandel coast, and apparently crossing the peninsula, re-appear on the opposite coast. I say *apparently* crossing the peninsula, for it is extremely doubtful whether in the majority of instances, perhaps in any case, a vortex formed over the Bay of Bengal ever really crosses the peninsula.* The experience gained from the study of such cyclones of this class as have occurred in recent years is, that vortices which cross the coast line, in the southern part of the peninsula, are only traceable, as such, as far as the hills of the Eastern Ghats. On meeting the high lands of the interior, they are broken up, but are reformed on the west coast, and thence, in certain cases, pursue their north-westerly course across the Arabian Sea. In certain cases, it is possible that, instead of passing away from the coast on a north-westerly course, they run up the coast towards Kathiáwar, and are thus felt successively at all the ports of the west coast. Such, according to Mr. Chambers, was the case of the storm of the 21st to 26th May, 1879, (No. 67 of the list). But so little has hitherto been published bearing on the study of storms on the west coast of the peninsula, that this and many other points must be left for future determination.

An excellent illustrative case of one of these storms is that which was formed off the coast of Ceylon, on the 11th November 1881. This vortex reached the Coromandel coast, crossing it between Madras and Negapatam, on the morning of the 13th, and by 10 A. M. of that day, the centre lay not far to the west of Madras, moving apparently on a north-west course. At the same hour, a new vortex was forming on the west coast, immediately to the south of Goa; and on the afternoon of the same day, was felt with some little severity at the ports of the Southern Concan and Malabar. A weather chart of the peninsula, at 10 A. M. of the 13th November is given in Plate X. In this case, the simultaneous existence of the two vortices is demonstrable, owing to the fact of their concurring at one of the regular hours of observation at Indian observatories. This of course may not always happen.

It is still a question whether, even in the sense of the foregoing description, storms cross the peninsula, from that part of the coast running to the north of the Godavery delta. That they do not always follow this course, even after striking the coast of the Carnatic south of the Kistna, is proved by the instance of the cyclone of the 16th—22nd May 1877, which reached the Madras coast near the mouth of the Pennair River, on the evening of the 18th May, and then passed up the line of the Eastern Ghats to Orissa, and thence inland to Behar and Northern Bengal.

There is, however, another class of storms, generated on the coast still further north, which pass inland, traversing a great part or even the whole breadth of Northern India,†

* Since the above was written, *viz.*, between the 24th and 27th November 1882, a storm has occurred forming, an exception to this rule, and showing therefore that, although exceptional, such travelling vortices do sometimes occur.

† One of these formed on the coast of Orissa and the Sunderbuns on the 18th July of the present year (1882), traversed the whole of Northern India, reaching Mooltan and Jacobabad on the 24th.

and which occasionally, though rarely, may possibly have a certain connection, at least as precursors, with the land-formed storms of Gujarat. These are the cyclones of the summer monsoon, to which Mr. Eliot has drawn attention in the first memoir of this volume, and which, in some years, are formed, in frequent succession, in the north-west corner of the Bay of Bengal. The barometric depression in these storms is very small, scarcely ever exceeding 0·2″ or 0·3″; the central depression is generally many miles, sometimes more than one hundred miles across, and the winds around are, as a rule, moderate; but they are often accompanied with heavy rain, and are very persistent. Their most ordinary course is about WNW. or W by N. It was one of these storms, in September 1880, that led up to the deluge of rainfall in Rohilkhand and the Almora hills, that produced the catastrophe of the Naini Tal landslip; and another was the precursor, with an interval of some days, of the Gujarat storm of July 1881. This I shall presently notice at more length, and will now return to the consideration of those of the Bombay coast.

Of storms probably formed over the Arabian Sea, in the neighbourhood of the Lakhadives, or between those islands and the Indian coast, and which, travelling to the east of north, are felt severely on the coast of Bombay or Kathiáwar, we have no further information than a few meagre references in Piddington and other writers. They are probably of rare occurrence, and constitute but an insignificant proportion of the storms of the Arabian Sea, if we may judge from the analogy of the Arakan coast and the storms of the Bay of Bengal.

The land-formed storms of Western Rajputana and Gujarat fall naturally into two classes; those of the cold season, and those of the summer monsoon. To the former belong the five storms Nos. 42 (probably 51), 55, 57 & 58 of Mr. Chambers' list; to the latter, in all probability, Nos. 49, 62, and with absolute certainty, as a typical example, No. 70. It is very likely that Nos. 44 and 54, and possibly No. 13, should also be included in this latter category, but the data are insufficient to determine the point in a satisfactory manner, and I have therefore not enumerated them in my list of exclusions from the marine storms.

The storms of the first class are phenomena of the winter rains of Northern India. The cases of cold-weather rainfall that have been discussed in the Reports on the Meteorology of India in 1878, 1879 and 1880, afford several instances of local barometric depressions, being formed in the plain region to the west of the Aravalis; most frequently perhaps in Sind and the adjoining portion of the Bickaneer desert. Such were the barometric minima formed between the 22nd and 23rd January 1878, on the 24th December 1879, and February 8th, 1880. Indeed, the general result of these discussions has been to shew that, the cold-weather rainfall usually begins on the northern margin of a barometric depression, which first appears in this region; the rain beginning in the Punjab, and afterwards extending to the North-Western Provinces, and sometimes to Bengal, as the depression moves eastwards. Indeed, on considering the fact, that the plateaux of Central India and the Central Provinces are normally a region of high pressure during the winter months, the tendency to high pressure here, in the heart of India, being more persistent than even in the Punjab and Sind, (where the pressures, though occasionally much higher, are interrupted by greater oscillations); it is easy to see that, in accordance with the law of wind circulation around barometric maxima, there must

be an occasional tendency to southerly winds in Cutch and Kathiáwar. Moreover, the average monthly charts for the winter months, published in the Meteorological Reports for recent years, shew that, at that season, there is usually a region of low relative pressure around the Gulf of Cambay; and that sometimes, as was the case throughout the cold season of 1880-81, the whole of the region west of the Aravalis shares this tendency. That the barometric minima, here formed, should sometimes be sufficient to give rise to wind pressures and velocities such as those recorded in Mr. Chambers' list, is a fact, which, if previously unrecognised, is quite reconcilable with our previous knowledge.

The conditions which lead to the formation of cyclonic storms in this region in the summer monsoon, are very different. The storm of the 11th—13th July 1881 is the only instance that has yet been studied in detail; but it may, in all probability, be taken as typical of this class of storms. I shall therefore describe it fully, reviewing, in the first place, the conditions antecedent to its genesis.

Cyclonic storm in Gujarat of the 11th—13th July 1881.

The monsoon rains set in on the Bengal side at an earlier date than usual, *viz.*, about the first week of June. On the Bombay side, they were much retarded, and although some rain fell during June, the western branch of the monsoon scarcely penetrated to the interior of the country, in force, until the end of the month. And the Bengal branch, after bringing more or less rain to the whole of Northern India, (except the region west of the Aravalis), between the 8th and 15th, fell off in strength, and the rainfall was followed by nearly a fortnight of dry weather with north-westerly winds in the Upper Provinces, lasting until the 25th or 26th of the month. It was not until the 29th, that the monsoon was reported to be fairly established on both coasts.

During the rainfall of June, the trough of low pressure which runs across Northern India in the monsoon months, dividing the western or Bombay from the eastern or Bengal branch of the monsoon, lay well to the south of the Ganges and Jamna. In the beginning of July also, it most frequently held this position, as, *e. g.*, from the 3rd to the 7th, and again after the 9th. On the 2nd of the month, one of those cyclonic vortices, to which reference has already been made, and which are a characteristic phenomenon of the rainy season, appeared on the coast of Orissa; and, on the 3rd and 4th, advanced westward, along the barometric trough between the two branches of the monsoon; the centre reaching Sambalpur on the 3rd, and Seoni on the forenoon of the 4th. On the 5th, the vortex was still traceable in the neighbourhood of Guna, but the local barometric depression had almost disappeared; and on the 6th, completely so, being merged in the trough, which, on this day, extended almost in a straight line from Benares to Jacobabad. The pressure, at Jacobabad, corrected for difference of level, was only ·030″ lower than at Benares.

Up to the 9th, the seat of lowest pressure had been generally in the Punjab; chiefly at Peshawar, and in the Derajat; but, on one or two occasions, when rain fell in the Punjab, the barometer had risen, and more especially at Dera Ismail Khan and Mooltan; producing a local maximum over one or both of these stations. Such was again the case on the 10th of July, after two days of extraordinarily heavy rain, in the Punjab, Rajputana and Central India, and the western districts of the North-Western Provinces

The following falls, registered in these provinces on the 8th, 9th and 10th July, will afford some idea of the unusual copiousness and extent of this rainfall :—

	8th.	9th.	10th.	3 days' Total.		8th.	9th.	10th.	3 days' Total.
Lahore . . .	—	1·65	5·05	6 70	Bhopal . . .	2·85	0·78	0·45	4·08
Amritsar . .	0·30	8·90	5·60	14·80	Sutna . . .	—	3·36	0·38	3·74
Jullunder . .	0·70	—	7·30	8·00	Nagode . . .	—	2·40	1·00	3·40
Hoshyárpur . .	3·50	—	7·00	10·50	Rewah . . .	0·25	0·36	3·65	4·26
Ludhiana . .	0·40	—	6·00	6·40	Dera Dun . .	1·47	1·25	0·05	2·77
Umballa . . .	1·10	1·90	0·70	3·70	Saharanpore . .	2·50	0·20	0·80	3·50
Delhi . . .	4·45	0·61	1·30	6·36	Bulundshahr . .	4·00	—	0·20	4·20
Bickaneer . .	4·28	0·13	0·05	4·46	Bareilly . . .	0·91	4·11	—	5·02
Bhurtpore . .	—	3·88	0·18	4·06	Agra	—	3·40	0·80	4·20
Jeypore . . .	—	3·19	1·36	4·55	Mainpuri . .	—	2·30	0·30	2·60
Delhi . . .	—	4·80	0·04	4·84	Etah . . .	—	4·50	0·20	4·70

On the forenoon of the 10th, over nearly the whole of extra-tropical India, the barometer, reduced to its sea-level value, indicated a pressure of less than 29·6″. The isobar of 29·6″ ran from Rawalpindi, almost in a straight line to the Ganges, a little west of Patna, thence to the north of Berhampore, and curving to the south through the middle of the Gangetic delta, and enclosing the western half of the delta and the north-west corner of the Bay, intersected the coast line near Gopalpur, and returned westwards, between Seoni and Nagpore, to Hoshangabad; whence it followed the course of the Nerbudda, to the Gulf of Cambay. Within this area, the differences of pressure were small; but, along its axis, were ranged three, or perhaps, two local depressions, in which the pressure was below 29·55″, and which were therefore the regions of minimum pressure in India. The westernmost and largest of these included nearly the whole of Rajputana, Upper Sind, Cutch and Northern Gujarat; the lowest pressures within which, were Ajmere 29·526″, Bickaneer 29·524, and Jacobabad 29·534″ (reduced to sea-level values). The next comprised a small area around Saugor, at which the reported reading (reduced to sea-level) was 29·512″. This, however, is not quite certain, as the readings of the Saugor barometer are not very trustworthy. Moreover, the depression, the existence of which is further indicated by the barometer readings to Nowgong and Jhansi, may possibly have been not independent, but an extension of that of Western Rajputana. The third centered at Saugor Island in the Sunderbuns, where the barometric reading was 29·504, the lowest recorded in that day; and the depression included Calcutta and apparently extended some distance to the north-west in the direction of Hazaribagh.

Within and around the great western depression, the concentration of which subsequently gave birth to the Gujarat cyclone, the winds, at 10 A.M. of the 10th, were NNW. at Pachbudra, NNE. at Bickaneer, N. at Ajmere, calm at Sirsa, E. at Agra, Allahabad and Benares, calm at Jhansi and Nowgong, NE. at Sutna, W. at Jubbulpore, and SW. at Saugor, NW. at Pachmarhi and Seoni, SW. at Indore, Neemuch and

Deesa, W. at Surat, WSW. at Rajkot, WNW. at Bhuj; SW. at Kurrachee, calm at Hyderabad, SE. at Jacobabad, and NE. at Mooltan. At Surat, the average rate of movement, during the preceding 24 hours, was only 14 miles an hour, at Rajkot 8 miles, and at Ajmere 2 miles an hour. At Deesa the velocity was not reported.

On this day, therefore, there was no appearance of a storm. There was an extensive but slight barometric depression in Western India, within which, the winds were light or calm. Within this area, the lowest pressures, at 10 A.M., reduced to sea-level values, were observed at Pachbudra, Bickaneer and Ajmere, and were as follow :—

	Observed.	Reduced to sea-level.
Pachbudra	29·130 ins.	29·525 ins.
Bickaneer	28.746 „	·524 „
Ajmere	27·934 „	·526 „

but the winds, at all these stations, were northerly; and, only at Deesa and Neemuch, from an opposite quarter, *viz.*, south-west.

At 10 A. M. on the following morning, the 11th July, the distribution of the pressure was as shewn of the chart, Plate XI. The barometric readings (reduced to 0° at the sea-level values,) and their changes since the corresponding hour of the previous day, were as follow. The table shews also the temperature, wind direction, and total movement in 24 hours, the relative humidity and vapour tension, cloud proportion, and the rainfall recorded on the afternoon of the day.

Weather Table of 11th July.

Stations.	Reduced barometer at 10 A.M.		Temperature, 10 A. M.	Wind		Vapour tension, 10 A.M.	Relative humidity, 10 A.M.	Clean proportion, 10 A.M.	Rainfall, ins.
	Reading.	Change since 10 hours preceding day.		Direction, 10 A. M.	Movement. Miles.				
Jacobabad	29·582	+·048	95·8	ENE	194	·845	50	4	...
Mooltan	·644	+·055	84·0	NE	101	·661	57	10	0·05
Sirsa	·566	+·012	88·5	E	210	·982	73	9	...
Agra	·552	—·007	88·2	E	181	·971	73	8	...
Jeypore	·543	—·001	82·7	ESE	213	·941	67	9	0·60
Ajmere	·528	+·002	79·3	SE	81	·888	89	10	1·12
Bickaneer	·527	+·003	81·7	NE	168	·672	61	10	1·25
Pachbudra	·496	—·029	90·1	NE	143	·889	63	9	0·77
Deesa	·500	—·048	87·6	NNW	?	·999	76	9	0·65
Neemuch	·534	—·014	79·8	WSW	51	·846	83	8	...
Indore	·555	—·019	79·4	SW	127	·814	81	8	0·01
Khandwa	·575	—·033	80·3	Calm	103	·856	83	9	0·87
Malegaon	·607	—·059	80·9	W	427	·820	78	10	0·06
Surat	·571	—·044	79·6	SW	374	·962	95	10	2·82
Rajkot	·589	+·002	78·0	W	420	·851	89	10	6·03
Bhuj	·548	+·004	86·2	WNW	584	·975	78	10	1·05
Hyderabad	·533	—·024	98·0	N	203	·839	46	1	...
Kurrachee	·591	+·032	92·0	W	430	1·029	69	2	...
Bombay	·702	—·007	76·3	WNW	759	·912	98	8	2·02

The barometric changes, in the previous 24 hours, consisted in a rise of pressure in the Indus valley, greatest at Mooltan; and a slighter rise throughout the Punjab and in Northern Rajputana. In Kathiáwar and Cutch, the change was insignificant. But at Pachbudra, Deesa, Surat, Malegaon, and to the eastward, in Berar and Nimar, there was a considerable fall; the result being the production of a local minimum between Pachbudra and Deesa. It was however a very slight depression, as far as is shewn by the registers; and although the winds of Pachbudra, Ajmere, Neemuch and Deesa were distinctly cyclonic around it, they were very light in the neighbourhood of the minimum. Only to the south and west, at Surat, Rajkot, Bhuj and Kurrachee, the monsoon current from the Arabian Sea blew strongly: and only at Bhuj, did even this current exceed the average velocity of the month.

On this day and hour then, the vortex was in process of formation, but, as yet, there was scarcely such a disturbance as to give rise to a wind of stormy violence.

A question, of much interest, which presents itself in connection with the generation of this storm, is whether the barometric changes which apparently caused the concentration, in the neighbourhood of Deesa, of the previous extensive and nearly equable depression, *viz.*, the rise in the Indus valley and on the north, and the fall in the area of Deesa, Surat, Malegaon, &c., can be traced back to any pre-existent conditions shewn by the registers.

As regards the former of these phenomena, *viz.*, the rise of pressure under the western hills, I have already observed that, on one or two occasions previously, a fall of rain in the Punjab had been followed by a rise of pressure in the Derajat and at Mooltan; and that the rise on the 10th (of which the further rise on the 11th was merely the prolongation,) was another instance of the same kind; and followed on the unusually heavy rain in the Punjab, (and other Provinces) of that and the two previous days. What may be the precise causal sequence of the phenomena, the physical connection of rainfall in the Punjab with a subsequent rapid rise of pressure in the Indus valley, is a question, which, at present, we are hardly in a position to answer satisfactorily; but that there is such a connection is, to my mind, amply established on an empirical basis, by the frequency of the sequence at all seasons of the year, and most strikingly, perhaps, in the case of the cold-weather rainfall.*

We may, then, regard the rise of pressure in the Indus valley and the Punjab, as a probable consequence of the unusually heavy rain of the 8th, 9th and 10th, and the northerly winds of the Indus valley and Northern Rajputana as the result of the difference of pressure, thus established, between the Punjab and the depression already existing in Western Rajputana and Northern Gujarat.

On the 11th, scarcely any rain fell in the Punjab and Sind, but it was still general in Rajputana, Central India, the Central Provinces, Cutch and Gujarat, as well as in the Konkan and Khandesh, and was especially heavy at certain stations in Kathiáwar, Surat, Broach, and the eastern districts of Gujarat. It had indeed fallen continuously, in this region, for several days; and as, at some stations, it had also been very heavy on the

* See, for example, the Report on the Meteorology of India in 1878, pp. 129, 130; Report for 1879, pp. 136 and 154; and Report for 1880, pp. 143, 144 and 171. In the Report for 1880, pp. 170, 171, the probable physical connection of the phenomena in question is briefly discussed.

10th, the day which immediately preceded the formation of the vortex, I give the rainfall of that day also— *

Rainfall around storm area on 10th and 11th July.

Province.	Stations.	Rainfall. 10th.	11th.	Total.	Direction from centre on 11th.	Province.	Stations.	Rainfall. 10th.	11th.	Total.	Direction from centre on 11th.
		ins.	ins.	ins.				ins.	ins.	ins.	
Rajputana.	Bickaneer	0·05	1·25	1·30	N by E	Gujarat.	Dhulia	0·84	0·27	1·11	SSE
	Jeypore	1·36	0·60	1·96	NE		Malegaon	...	0·06	0·06	SSE
	Beawar	6·30	0·30	6.60	NE		Surat	0·05	2·87	2·92	S
	Ajmere	1·05	1·47	2·52	NE		Broach	0·52	7·64	8·16	S
	Jodhpur	0·38	0·16	0·54	NNE		Baria	0·11	1·29	1·40	SE by S
	Pachbudra	...	0·77	0·77	N		Godra	0·85	0·92	1·77	SE by S
	Nusseerabad	1·26	0·42	1·68	NE		Kaira	1·23	3·45	4·68	S by E
	Teuk	0·15	0·69	0·84	ENE		Ahmedabad	0·88	2·80	3·68	S by E
	Deoli	0·04	0·11	0·15	ENE		Idar	3·78	3·31	7·09	SSE
	Shahpura	0·74	1·26	2·00	ENE		Pahlanpur	1·28	1·28	2·56	S by E
	Erinpura	2·00	1·15	3·15	E		Deesa	3·47	0·65	4·12	S
	Oodeypore	0·26	0·96	1·22	ESE		Rajkot	0·71	6·03	6·74	SSW
	Kotra	0·68	0·55	1·23	SE	Sind and Cutch.	Bhuj	0·21	1·05	1·26	SW
	Kherwara	0·03	0·72	0·75	SE		Nagger Parker	...	0·21	0·21	SW by W
	Banswara	0·12	0·23	0·35	SE		Umerkot	...	...	0	W
	Partabgarh	0·45	0·26	0·71	SE		Hyderabad	...	...	0	W
Central India.	Neemuch	0·58	0·05	0·63	ESE		Tatta	...	...	0	W by S
	Do. observatory	0·07	...	0·07	ESE		Kurrachee	...	...	0	W by S
	Rutlam	0·65	2·07	2·72	SE by E						
	Indore	0·14	0·17	0·31	SE by E						
	Sirdarpur	0·07	0·18	0·25	SE						
	Manpur	0·15	0·20	0·35	SE						

From the above it appears that, on the 10th, the region of heaviest rainfall was an interrupted band ranging from north-east round to south of the site occupied by the depression on the forenoon of the 11th, the heaviest falls being at Beawar, Idar, Deesa and Erinpura, and, as appears from the table at the end of this paper, at certain stations in Kathiáwar, Surat, and the Panch Mehals (east of Baroda). This does not coincide with that in which the chief barometric fall between the 10th and 11th took place, although it lay partly within it. Neither does this latter region coincide with that in which the movement of the air was greatest, nor that in which the greatest increase of movement took place, since, at Pachbudra, where the average movement was but 8 miles an hour, and at Khandwa, where it was calm, the fall was in the former case half as great, in the latter more than half as great as at Malegaon, where the movement was over 30 miles in the hour, having been above 6 miles on the previous day at 10 A.M.; while there was no fall of pressure at Rajkot, where it had increased from 10 to 18 miles an hour.

* The fall registered at a large number of minor stations in all the northern districts of the Bombay Presidency is also given in an appendix to this memoir (pp. 99-101).

The area within which the barometer fell, was limited to a circumscribed portion of Northern and Western India, and is marked by a dotted line on the chart, Plate XI. Within this, there were apparently two independent areas of maximum fall, the one chiefly in the Gangetic plain, defined by Durbhanga, Patna, Gorakhpur, Allahabad, Lucknow, Bareilly, and Meerut, and, to the south of the river, Nowgong; the other, partly in the peninsula and partly in Western India, and including Hyderabad (Sind), Deesa, Pachbudra, Surat, Malegaon, Khandwa, Buldana, Sholapur, and Secunderabad, and centering at Malegaon. At Deesa, Surat, Malegaon, Buldana and Sholapur, the fall exceeded ·04″. The fall in the 24 hours, from 10 A.M. of the 10th to 10 A.M. of the 11th, was as follows:—

Northern area of maximum fall.

	Fall.		Fall.
Durbhanga	—·035 ins.	Nowgong	—·030 ins.
Patna	—·030 „	Lucknow	—·032 „
Gorakhpur	—·035 „	Bareilly	—·027 „
Allahabad	—·041 „	Meerut	—·034 „

South-Western area of maximum fall.

	Fall.		Fall.
Hyderabad	—·024 ins.	Khandwa	—·033 ins.
Pachbudra	—·029 „	Buldana	—·044 „
Deesa	—·043 „	Poona	—·026 „
Surat	—·044 „	Sholapur	—·044 „
Malegaon	—·059 „	Secunderabad	—·030 „

All around this area, except (as far as is known) in the Himalayan region, to the north of the Gangetic plain, the barometer rose. The greatest rise was in the Indus valley and in the south-west of Bengal, where the changes were as follow:—

Indus valley.

	Barometric Rise.
Dera-Ismail-Khan	+·040 ins.
Mooltan	+·055 „
Jacobabad	+·048 „
Kurrachee	+·032 „

Lower Bengal.

	Barometric Rise.
Cuttack	+·037 ins.
Saugor Island	+·072 „
Calcutta	+·052 „
Burdwan	+·023 „

That these changes of pressure, though small, had a certain significance as a part of the phenomena that determined the formation of the vortex, there can be little or no doubt; but it is not easy to correlate them, except partially and imperfectly, with the other circumstances of the local meteorology; and it is highly improbable that either the fall of pressure over the circumscribed area above defined, or the rise of pressure around its borders, is directly referable to any single elementary change of condition in the region affected.

Assuming that all changes of atmospheric pressure, whether due to static or dynamic causes, may be traced back to changes of static pressure, and that, of the causes producing changes of static pressure, the changes of atmospheric density, due to variation of temperature, are by far the most efficacious, the question remains, whether the higher or lower strata of the atmosphere are the seat of any given action of the kind. If the former, the most important agent indicated by physical considerations is the substitution of a saturated and condensing mass of air, for one which is dry and non-condensing; and which, in ascending as a continuous current, displaces cooler and

heavier air, while its deposited cloud arrests and absorbs a larger portion of the incident solar radiation. It is a matter of daily observation in India, that such an action is accompanied with a fall of temperature at the earth's surface; and thus the reduction in the density of the higher strata does not affect a barometer on the earth's surface to the full extent of the change, locally effected, but only in so far as this is not compensated by the increased density of the lower stratum regarded as of constant vertical thickness.

If, on the other hand, the lower atmosphere be the seat of the action, this may be brought about either by a change of wind, a warmer current replacing one from a cooler quarter, or by the local absorption of heat, either solar radiation or that from the ground heated by the sun. In India, in the month of July, it is mainly with the latter condition that we have to deal. In this case, the higher strata will not, of necessity, be much affected. Any reduction of static pressure is, in this case, at its maximum at the earth's surface, and diminishes more or less rapidly as the elevation increases.

Now, it is obvious, on comparing the above two cases, that a small reduction of pressure shewn by the barometer at the earth's surface, if due to the former kind of action, indicates a far greater disturbance of local equilibrium than if due to the latter; and if, therefore, in an area of tolerably uniform barometric depression, the observed change be partly due to the one, partly to the other action, that portion of the area, in which the higher atmospheric strata are primarily affected, will be the seat of most active indraught and further precipitation.

So far with regard to static changes. But so soon as a rapid current of air pours in from any quarter towards an area of reduced pressure, a redistribution of atmospheric pressure is set afoot by dynamic action. The fall of pressure, originally local, will be communicated to the surrounding region; and especially, in consequence of terrestrial deviation, to that which lies to the left hand of the strongest current; in the case of a west wind, *viz.*, the region immediately to the north.

Now, applying these considerations to the case before us, we find that in Western India the seat of the greatest fall of pressure was partly in Gujarat and Surat, partly in Khandesh, Berar and the Deccan. The former was also the seat of very heavy rainfall, both on the 10th and 11th; and the temperature, as far as appears from the registers of Surat and Rajkot, was low and falling. At Deesa, there was a rise of temperature, which is in accordance with the usual experience, the rain having been very heavy on the 10th, and but slight on the night of that day and during the 11th. But in a portion of the Deccan, as represented by Poona, Buldana, Chanda and Nagpur, there was a general rise of temperature, most considerable at Chanda and Nagpur, both situated in the heart of a rainless region. The data here dealt with are as follow. I include a number of the surrounding stations, in order to shew the better the general character of the temperature changes in the two tracts here contrasted :—

	Temperature at 10 A.M.				Temperature at 10 A.M.		
	10th.	11th.	Change.		10th.	11th.	Change.
Deesa	83·0°	87·6°	+4·6	Malegaon	84·1°	80·9°	—3·2
Neemuch	81·0°	79·8°	—1·2	Buldana	78·6°	79·8°	+1·2
Indore	78·8°	79·4°	+0·6	Poona	75·0°	76·8°	+1·8
Rajkot	83·2°	78·8°	—5·2	Sholapur	83·3°	82·3°	—1·0
Surat	81·6°	79·6°	—2·0	Secunderabad	80·6°	78·6°	—2·0
Bombay	81·9°	77·3°	—4·6	Chanda	76·4°	81·1°	+4·7
Khandwa	83·3°	80·3°	—3·0	Nagpur	76·7°	80·7°	+4·0

It appears then, that as regards the Deccan the fall of pressure between the 10th and 11th may have been partly due to the increase of temperature, indicated by the latter stations of the above list. But as regards Gujarat and Surat with the neighbouring region to the east and south-east, the fall of pressure was accompanied with a very marked fall of temperature; and as it was an area of excessive precipitation, in the absence of any other apparent agency competent to produce this local reduction of pressure, we may attribute it, with some probability, to the active condensation going on in the higher strata of the atmosphere. The result was a great increase in the strength of the westerly monsoon, which fed the rainfall; and this, in accordance with the principle above laid down, determined a fall of pressure immediately to the north, and a transfer of the pre-existing minimum to the more southerly position which it occupied at 10 A.M. of the 11th, and which is shewn on the chart, Plate XI. The increase in the strength of the monsoon current, across Kathiáwar, Surat and Khandesh, and its simultaneous decrease in Cutch, are shewn in the following table, in which the rate of movement in miles per hour, at the hours of observation, 10 h. and 16 h. are given, as computed from the total movements recorded in the intervals. As these are alternately periods of 18 hours and 6 hours, on the assumption that the total distances indicated by the anemometer, when divided by 18 and 6 respectively, give the velocity at the middle of each period, the rate at 10 hours is computed by adding the mean velocity of the preceding 18 hours to three times the mean velocity of the succeeding 6 hours, and taking one-fourth of the sum. In like manner that for 16 hours is obtained by adding three times the mean hourly movement of the preceding 6 hours to that of the following 18 hours, and dividing by 4. This method of computation, although rough, probably gives an approximation sufficient for the present purpose. For Deesa, unfortunately, the anemometric data are wanting. Those for Bombay are taken from the traces of the Beckley's anemograph at the Colaba Observatory, and are actual rates :—

Computed wind velocity miles per hour.

Stations.	10th July.				11th July.			
	10 h.		16 h.		10 h.		16 h.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Kurrachee	SW	21	WSW	23	W	24	WSW	25
Bhuj	WNW	46	SW	50	WNW	23	W	22
Rajkot	WSW	10	SSW	13	W	19	WSW	21
Surat	SW	19	SW	28	SW	35	SSW	37
Malegaon	W	7	WSW	6	W	32	W	32
Bombay	SW	24	WSW	34	W	29	W	30

Up to the evening of the 11th, the barometric depression was but slight. At 4 P.M. of that day, the seat of lowest pressure lay evidently between Deesa and Neemuch, the

lowest pressure shewn on the chart, (Plate XI), being, as reduced to sea-level values, 29·357″ at Deesa, and 29·368″ at Neemuch. In the 6 hours that had elapsed since 10 A.M. of the forenoon, the seat of minimum, as far as this can be inferred from the registers, had been transferred about 100 miles to the south-east, or directly towards the seat of excessive rainfall of this day in Eastern Gujarat, and also towards the rapidly increasing monsoon current shewn in the above table at Surat and Malegaon. The fall of pressure, in these 6 hours, at the stations in this part of Western India was, as shewn in the first column of the following table. The second column gives the normal diurnal fall for the month of July, and the third the residual fall which may, therefore, be regarded as abnormal, and as an effect of the local condensation :—

Barometric change from 10 hours to 16 hours of the 11th July.

	From obs.	Normal.	Abnormal.
Pachbudra	— 0·101 inch.	— ·097	— ·004
Deesa	— 0·133 „	— ·103	— ·030
Bhuj	— 0·112 „	— ·073	— ·039
Rajkot	— 0·069 „	— ·079	+ ·010
Surat	— 0·104 „	— ·081	— ·023
Malegaon	— 0·083 „	— ·081	— ·002
Bombay	— 0·089 „	— ·067	— ·022
Khandwa	— 0·093 „	— ·088	— ·005
Indore	— 0·124 „	— ·089	— ·035
Neemuch	— 0·115 „	— ·079	— ·036

Up to the afternoon of the 11th, there was no concentration of the storm; there was an extensive barometric depression and a slight circulation of air around; but no distinct storm vortex. This latter appears to have formed, rapidly, between Rajkot and Bhuj, on the night of the 11th—12th July*, and by 10 A.M. of the 12th, was well established in the position, which it retained, with but slight change, until it broke up on the afternoon of the 13th; as is shewn by the charts for 10 h. and 16 h. of the 12th and 13th July (Plates XII and XIII). The registers of temperature, pressure, and wind, vapour tension, humidity and cloud for these several hours, and the abnormal changes of pressure (after deducting the normal oscillations), for each interval after 16 h. (4 P.M.) of the 11th, are given in the following table, for the same stations as were enumerated in the table for the 11th on page 86. The velocity of the wind at the hour of observation has been computed in the manner already described.

* See the report of Colonel Burton, Political Agent, Kathiáwar, *postea*, p. 97.

Weather Table of the 12th July.

Stations.	10 A.M.								4 P.M.								Rainfall, 24 hours.
	Reduced barometer.		Temperature.	Wind.		Vapour tension.	Relative humidity.	Cloud proportion.	Reduced barometer.		Temperature.	Wind.		Vapour tension.	Relative humidity.	Cloud proportion.	
	Reading.	Abnormal change.		Direction.	Miles, hourly.				Reading.	Abnormal change.		Direction.	Miles, hourly.				
Jacobabad	29·530	—·018	94·9	SW	4	·838	51	8	29·381	—·010	98·6	SSE	3	·825	45	9	...
Mooltan	·535	—·089	94·0	Calm	1	·832	52	6	·387	—·049	93·0	Calm	2	·665	43	7	...
Sirsa	·509	—·038	92·9	E	12	·921	59	3	·379	—·026	97·7	SE	14	·846	47	1	...
Agra	·477	—·051	88·2	E	13	·971	73	10	·317	—·013	89·2	E	13	1·056	77	8	0·67
Jeypore	·491	—·024	84·9	ESE	?	·941	87	8	·414	+·001	80·9	SSE	?	·911	95	10	0·43
Ajmere	·473	—·025	82·3	NE	6	·893	81	9	·407	+·003	82·3	SE	5	·850	77	9	2·16
Bickaneer	·474	—·054	88·2	ENE	8	·752	56	5	·306	—·031	92·1	SE	8	·881	58	10	...
Pachbudra	·442	—·049	90·0	E	11	·933	66	5	·316	—·024	94·5	S	11	·829	51	8	...
Deesa	·464	—·019	77·9	SSE	?	·913	95	10	·341	+·001	83·2	S	?	·867	77	8	0·25
Neemuch	·492	—·005	79·1	SSW	8	·826	83	10	·362	—·014	83·7	WNW	10	·827	62	9	...
Indore	·533	+·004	76·1	S	8	·835	93	10	·461	+·033	76·0	SW	8	·816	91	10	0·33
Khandwa	·565	—·011	77·3	SW	9	·854	91	9	·493	+·016	77·3	SW	8	·856	91	9	0·11
Malegaon	·607	—·002	81·9	WSW	18	·741	68	10	·507	—·001	84·7	W	17	·707	59	10	0·02
Surat	·525	—·018	80·8	SSW	30	·946	90	10	·448	+·011	83·4	SW	31	·948	83	10	2·50
Rajkot	·413	—·188	74·2	W	44	·814	96	10	·229	—·090	75·1	W	49	·855	98	10	5·93
Bhuj	·346	—·166	79·1	N	27	·954	96	10	·153	—·105	81·1	NNW	28	·974	91	10	4·63
Hyderabad	·538	+·025	86·3	NNE	16	·764	61	10	·441	—·001	81 2	N	18	·959	90	5	0·19
Kurrachee	·492	—·057	90·5	W	16	·917	63	6	·406	—·012	85·3	WSW	15	1·020	82	9	0·02
Bombay	·653	—·026	80·3	WSW	34	·934	90	10	·572	—·004	81·0	WSW	28	·935	89	10	1·02

Weather Table of the 13th July.

Stations.	10 A.M.								4 P.M.								Rain fall, 24 hour.
	Reduced barometer.		Temperature.	Wind.		Vapour tension.	Relative humidity.	Cloud proportion.	Reduced barometer.		Temperature.	Wind.		Vapour tension.	Relative humidity.	Cloud proportion.	
	Sea level reading.	Abnormal change.		Direction.	Miles hourly.				Sea level reading.	Abnormal change.		Direction.	Miles, hourly.				
Jacobabad	29·429	—·090	99·9	E	8	·857	44	3	29·335	+·034	101·8	ESE	10	·820	40	1	—
Mooltan	·451	—·030	97·0	SSE	10	·838	48	3	·385	+·028	93·0	ENE	10	·510	35	0	—
Sirsa	·471	—·011	92·6	ESE	17	·902	59	8	·423	+·035	82·1	SE	16	·932	85	10	—
Agra	·555	+·086	83·2	SE	5	·991	87	10	·482	+022	88·2	SW	4	1·070	80	8	0·67
Jeypore	·542	+·039	81·4	SW	?	·900	84	9	·486	+·035	82·9	SW	?	·930	82	9	0·41
Ajmere	·509	+·028	80·3	S	7	·918	89	9	·459	+·027	84·3	SE	8	·868	74	8	0·80
Bickaneer	·437	+·002	87·7	SW	6	·870	66	10	·353	+·032	93·1	SSW	5	·891	58	10	0·39
Pachbudra	·463	—·041	85·8	SE	8	·879	71	9	·382	+·021	90·8	SE	10	·834	58	5	0·18
Deesa	·448	—·015	78·1	SSE	28	·883	91	10	·382	+·042	80·8	SSE	?	·910	87	10	0·17
Neemuch	·556	+·083	82·3	SSW	12	·806	73	10	·500	+·033	82·5	SW	11	·817	73	5	0·28
Indore	·617	+·055	78·6	S	9	·755	77	10	·549	+·039	83·6	SW	9	·720	63	10	0·33
Khandwa	·631	+·058	83·3	SW.	9	·781	68	9	·561	+·016	89·3	SW	8	·658	54	9	—
Malegaon	·668	+·053	81·9	WSW	31	·648	70	8	·627	+·051	84·9	WSW	33	·697	54	5	—
Surat	·574	+·032	84·6	SW	28	·931	78	6	·502	+·010	82·8	SW	28	·964	86	9	0·19
Rajkot	·373	+·054	79·9	SW	43	·833	81	10	·401	+·106	78·0	WSW	39	·842	88	10	2·31
Bhuj	·250	+·007	77·1	NNW	22	·915	98	10	·307	+·017	77·1	W	24	·935	100	10	0·99
Hyderabad	·456	—·080	84·7	N	11	·986	82	10	·356	—·013	92·8	NNE	10	·967	62	5	0·19
Kurrachee	·430	—·051	83·1	WNW	16	1·035	68	9	·414	+·046	85·2	WSW	16	·997	93	10	0·64
Bombay	·699	+·050	82·5	SW	25	·908	85	8	·686	+·052	81·9	SW	24	·917	89	8	0·28

These registers shew that a considerable and rapid fall of the barometer at Rajkot and Bhuj accompanied the formation of the vortex on the 12th. To a less extent, the pressure diminished simultaneously over the whole of Western Rajputana and the Indus valley; and up to about noon, slightly, over nearly the whole region of Eastern Rajputana, Central India, Berar, Khandesh, &c. But, by the afternoon, a slight rise had set in at Indore, Khandwa, and some other of the more easterly stations, which continued and extended during the night of the 12th—13th, while the fall was still proceeding in the Indus valley; and by the afternoon of the 13th, the pressure was recovering over the whole region, with the single exception of Hyderabad. During the two days, it is evident that the vortex moved slightly north-westward, nearing and then passing somewhat to the north of Bhuj; but by this time it was rapidly breaking up.

The rainfall of the 12th was very general over the region to the east and south of the vortex, as on previous days; but was especially heavy in the immediate neighbourhood of the latter, in Kathiáwar and Cutch. The heaviest recorded rainfall, on the 12th, as far as is shewn in the above weather register, and in the table in the Appendix, was at Bhuj and Rajkot, and at a few other stations in Kathiáwar. The latter table shews also very heavy rain at some stations in Kathiáwar on the 13th, but I have no information at what hour the contents of the gauge were measured. But heavier falls than any recorded in these tables, are reported to have taken place at certain stations in the north-west of the peninsula of Kathiáwar, *viz.*, Nawanagar, Dhrol and Morvi. The authority for these heavier falls is an official report from Colonel L. C. Burton, Political Agent, Kathiáwar, also given in the Appendix, and there seems no reason to doubt the validity of the returns, notwithstanding that the quantities reported so much exceed any shewn in Mr. Pearson's rainfall return in the Appendix. All the stations, enumerated in this latter table, are either on the plain in the north of Kathiáwar, or to the south-east of the low hill range, that forms the watershed of the peninsula. Nawanagar, Dhrol and Morvi, on the other hand, are on the north-west slope of the hill range, and fully exposed to the violent saturated current then blowing across Gujarat. The slight physical obstacle presented by these hills, would probably, in such a current, determine a local excess, such as the Political Agent reports, *viz.*, between the 11th and 13th (or at Morvi up to the 14th).

Nawanagar	28·90 inches.
Dhrol	33·50 „
Morvi	25·54 „

Now it is exactly in this region that, as appears from the wind and barometric registers, the vortex was concentrated, and this coincidence is extremely significant in its bearing on the still much debated question of the origin of the barometric depression at the centre of cyclonic vortices. That the formation of cyclones is a consequence of heavy local rainfall is a general law, which not only has resulted from the discussion of every storm in the Bay of Bengal, which have been made the subject of special enquiry either by Mr. J. Eliot or myself, but it is the only view which appears to offer a satisfactory deductive account of the phenomena. But, hitherto, the only storms which have offered themselves for investigation, are such as have originated at sea; and the

only observations available have been those recorded on ships, with unverified instruments, and in positions which, in many cases, could be determined only approximately and with more or less probability of error. Added to which, all measurement of that most important element, the rainfall, around the birthplace of the storm, has been impracticable. It is therefore an occurrence of more than ordinary interest that presents itself in the Gujarat storm of the 11th and 13th July 1881; which, having been generated on a land surface, in the midst of well equipped meteorological observatories, has fulfilled, in a high degree, all those conditions that are demanded by scientific enquiry.

The successive steps in the formation of this storm, as they have been traced in the above discussion, are as follow :—

First.—There existed, on the 10th July, a very extensive area of low barometer, running across Northern India, and including two minima; the larger of which, of very slight intensity, occupied nearly the whole of Rajputana and much of the adjacent territory west of the Aravalis. Within and around this, the winds were very light, and very variable in direction, except on the south, where a strong south-westerly monsoon current blew across Cutch.

Second.—In the next 24 hours, the depression was slightly intensified, in consequence of a general slight barometric fall, over a well-defined area in Northern India and the northern half of the peninsula, and a slight rise around its borders. As regards the Punjab and Indus valley, the rise of pressure is an instance of a phenomenon very common in this region, at all seasons of the year, after rain; and, in this case, it followed on the cessation of unusually heavy rain. But rain continued over the northern half of the area of falling barometer (excepting in Sind and Western Rajputana), and was especially heavy in the east and south of Gujarat, *viz.*, along the Aravalis and in Kathiáwar; to the north-west of which region, a slight cyclonic circulation was set up, around the seat of minimum pressure. The strong monsoon current, which fed this rainfall, at the same time shifted to the south, the wind falling at Bhuj (in Cutch) and increasing at Rajkot, Surat, and Malegaon.

Third.—The heaviest rain of all was in the north-west of Kathiáwar, where the stormy west wind swept the opposed slopes of the low hill range that traverses that peninsula; but although the wind was high, there was no appearance of a cyclonic vortex in this region, until the night of the 11th. Whether the slight depression, with a cyclonic circulation around, which existed between Deesa and Neemuch, at 4 P.M. of that day, was rapidly intensified and transferred to between Bhuj and Rajkot (a distance of 200 miles), or whether a new vortex was formed by the eddying wind in the new position, the previous depression becoming evanescent, is a point on which evidence is wanting. But it is certain that the storm vortex which first appeared between Bhuj and Rajkot on the night of the 11th, coincided exactly in position with the seat of the heaviest rainfall, much of which had fallen during the previous day; and that, during the whole of the 12th and the forenoon of the 13th, it shifted but slightly to the westward of its place of origin, a deluge of rain falling without intermission immediately around.

APPENDIX A.

Report of COLONEL L. C. BURTON, *Political Agent, Kathiáwar, dated 18th July 1881.*

I regret to have to report, for the information of Government, that very great damage has been occasioned by the heavy storm that swept over this province last week.

The centre of the cyclone appears to have travelled in a north-easterly direction through the Halar, striking the land about midway between Porebunder and Dwarka, and passing over Nawanagar, Dhrol and Morvi,* and doing great damage in these towns and the surrounding country.

Reports from Nawanagar state that rain commenced falling on the 11th; the river Naginati, which runs by the town, was in flood early on that day, and penetrated into the houses, carrying away much property and cattle. On the night of the 11th, the wind increased to a gale and was accompanied by torrents of rain; the town was inundated; about 1,000 houses, it is computed, collapsed, and there was some loss of life. The storm continued, without cessation, until the afternoon of the 13th, 28 inches and 90 cents of rain being gauged.

The town of Dhrol has suffered even more severely, three-fourths of the houses are said to be in ruins; 33½ inches are reported to have fallen here during the storm.

Morvi was struck by the storm about 10 o'clock on the night of the 11th, after which it rained and blew, without intermission, for 30 hours. After a short lull, another fall took place, lasting 16 hours; and again on the 14th, the storm lasted from 10 A.M. until sunset. During its continuance, 25·54 of rain fell. The damage done has been very great, the extensive suburb of the town has been nearly destroyed, and all the valuable property, stored in warehouses there, washed away. Many houses in the town have fallen down, the jail was flooded and had to be vacated, and it is feared there has been considerable loss of life, as well as property, not only in Morvi itself, but throughout the district. Whole villages are reported to have been swept away; while the minor towns are stated to have suffered in a greater degree than the capitals.

The chiefs, with their usual liberality, are providing food and shelter for the homeless. The Thakore Saheb of Morvi distinguished himself by his activity. He went about the town during the storm, providing food and shelter for those in need of it, thereby giving an excellent example, and infusing energy into his subordinate officers.

In Rajkot, the storm was very severe during the 11th and 12th, but subsided on the 13th. The return of rainfall is as follows:—11th, 6 inches 16 cents; 12th, 6 inches 26 cents; 13th, 2 inches 30 cents; total 14 inches 72 cents. Considerable damage was done to buildings and trees, but it is evident that we escaped the full force of the storm, which appears to have had its axis in a line running from south-west to north-east, passing about 50 miles to the north of this station. In Iodiya, for instance, it is reported that 50 inches of rain fell during the storm.

A further report will be submitted when full particulars regarding the extent of the damages and loss of life have been received.

Report of H. N. REEVES, ESQ., *Political Agent, Cutch, dated 26th July 1881.*

With reference to the recent cyclone, the centre of which is said to have passed somewhere near Bhuj, I have the honour to submit certain information collected from some of the principal towns in Cutch, regarding the effects of the gale of wind and heavy rain, which occurred between 11th and 14th July.

From 6 P.M. on the 10th to 6 P.M. of 14th, 8 inches and 2 cents of rain fell at Bhuj. The readings of the barometer and thermometer, humidity of the air, the velocity and direction of the wind on the dates above mentioned, are given in Appendix A.† In the city and immediate neighbourhood, six houses fell down, 185 were partially injured, and 350 trees were blown down.

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* This inferential course of the storm is, of course, erroneous, as applying to the vortex. It almost describes the course of the most violent wind blowing up to the storm centre.

† Omitted here, the data for Bhuj having already been given in the Tables in the text.

The rainfall at Mandvi from the night of the 11th up to midday of the 14th is given below:—

12th July, Tuesday	. . . . .	14 inches 80 cents.
13th „ Wednesday	. . . . .	5 „ 74 „
14th „ Thursday	. . . . .	... ...
	Total .	20 inches 54 cents.

The readings of the barometer and thermometer on those three days, as well as the direction of the wind, were as follow:—

	Barometer readings.		Thermometer readings.	
	10 A.M.	6 P.M.	10 A.M.	6 P.M.
12th,	29·22	29·13	83	84
13th,	29·30	29·27	84	83
14th,	29·40	29·39	82	83

Direction of the Wind.

12th July	NW.
13th „	SW.
14th „	NW.

I regret to say that the barometer has been discovered to be out of order, so that the above observations are not quite correct; but the amount of rain, registered on the first two days, was quite abnormal. The water brought down from the Charwa range by the Bookee river, which flows past the town of Mandvi, cut away the sand bar between the point of the wharf wall and the groyne, and lowered it 6 feet. The channel of the river was widened, 2 feet at its mouth and 5 feet off the wharf wall, a part of which was injured, and one of the four end blocks which form a sort of pier head to the breakwater, sank several feet; 120 houses wholly or partially fell down; the number of the trees blown down has not been ascertained, but it is very great. Four large and five small Pattymars, value about Rs. 12,000, were carried out to sea. Timber stacked on the banks of the river, worth about Rs. 17,000, was washed away. A man who was in one of the boats when it floated out of the harbour, has not since been heard of.

There is no barometer at Anjar; the readings of the thermometer, the rainfall, and the direction of the wind, however, were recorded as follow:—

Thermometer readings.

	9 A.M.	6 P.M.
12th July	82	82
13th „	80	82
15th „	78	82

Rainfall.

12th July	6 inches.	56 cents.
13th „	1 inch	50 „
14th „	2 inches	64 „
Total	10 „	70 „

Direction of the Wind.

12th July	N.
13th „	N, S. W.
15th „	W.

In this district, 395 houses and 150 trees were more or less injured. Four head of cattle were swept away by floods. At Khari Rohur four boats drifted out to sea, and have not since been found. At Toona, 3 or 4 boats were injured by being violently dashed against one another. Some timber lying on the shore at this port has also disappeared. The bund, built by Shingjibhai of Mandvi, across the Toona river, last year, at a cost of Rs. 800, has been destroyed.

At Bachao the rain, registered in the town itself, during the three days and the night of the 11th, is as follows :—

Night of Monday, 11th July	7 inches	90 cents.
Tuesday, 12th July . . .	... .	16 „
Wednesday, 13th July . .	1 inch .	46 „
Thursday, 14th „ . .	2 inches .	89 „
Total	12 inches .	41 cents.

About 400 houses and 300 trees suffered damage in this taluka.

From the above facts and observations, it would appear that the centre of the cyclone did not reach Bhuj, the storm was more violent, and the rain fell more heavily at Mandvi than at Bhuj, and the State Engineer tells me that, so far as he can gather, it passed through the Gulf of Cutch or over the opposite coast of Kathiáwar.

APPENDIX B.

Statement giving the daily rainfall at stations in the districts enumerated in Gujarat and Sind.

Stations.	July 1881.					Stations.	July 1881.				
	10th.	11th.	12th.	13th.	14th.		10th.	11th.	12th.	13th.	14th.
Kathiáwar.						*Kathiáwar*—contd.					
Wadhwan . . .	0·22	2·22	1·72	0·10	0·33	Mahuwa . . .	2·30	1·59	0·32	0·92	0·10
Chotila . . .	0·80	0·45	1·45	0·60	0·25	Kundla . . .	0·34	0·45	0·34	1·09	...
Dassada . . .	0·40	...	2·85	0·13	0·90	Lilia . . .	0·88	0·72	0·17	0·91	...
Bhoika . . .	0·20	2·26	0·09	0·34	0·32	Oomrala . . .	5·61	2·32	0·50	...	...
Palliad . . .	0·28	0·40	...	1·25	...	Botad . . .	0·61	2·07	0·54	0·35	0·29
Jhinjuwada . .	0·50	0·25	2·60	...	1·23	Gadhda . . .	2·40	0·63	0·20	0·44	0·12
Vithalghad . .	0·15	3·87	...	0·35	0·43	Talaja . . .	6·88	3·60	0·11	0·38	0·27
Manekwara . .	1·24	0·96	1·06	1·98	0·28	Velavadar . . .	1·60	1·80	...	1·30	...
Lakhapadur . .	0·13	1·28	...	1·20	0·22	Palitana . . .	1·32	3·27	0·17	0·56	...
Bagasra . . .	1·01	0·68	0·33	1·55	0·34	Geriadhar . . .	1·60	1·25	0·05	0·20	1·00
Rafala . . .	6·54	5·68	3·70	4·20	0·48	Timba . . .	1·18	1·47	...	0·75	...
Jetpur . . .	1·98	0·65	0·53	...	...	Valukad . . .	1·22	1·40	0·15	1·10	0·05
Bilkha . . .	2·52	7·18	1·47	1·16	4·62	Thaduch . . .	2·00	2·50	...	0·30	...
Chital . . .	0·18	1·06	2·23	3·78	1·64	Vala	3·64	1·91	0·07	0·44	0·07
Mendarwada . .	5·16	1·92	0·98	0·46	...	Jasdan . . .	1·54	0·90	0·75	1·65	1·83
Gondal . . .	4·03	2·72	3·93	2·17	1·61	Vichhia . . .	1·62	0·50	0·34	0·47	1·00
Dhoraji . . .	0·75	2·87	4·30	3·50	1·12	Lathi . . .	0·95	0·90	0·25	0·98	...
Upleta . . .	2·80	4·95	4·85	4·45	0·93	Babra . . .	2·90	1·61	0·22	0·99	0·15
Sarsai . . .	1·33	1·05	1·22	1 48	0·34	Songadh . . .	2·97	2·91	0·21	0·62	0·04
Bhayawadar . .	2·40	4·92	4·38	3·97	0·58	Datha . . .	1·80	1·79	0·10	0·70	0·54
Bhavnagar . . .	3·03	3·61	0·05	0·63	0·03	Chamardi . . .	4·49	1·10	...	0·30	...
Sihor . . .	3·56	2·02	0·14	0·70	0·08	Chok . . .	3·60	2·00	...	...	0·2

Statement giving the daily rainfall at stations in the districts enumerated.—continued.

Stations.	July 1881.					Stations.	July 1881.				
	10th.	11th.	12th.	13th.	14th		10th.	11th.	12th.	13th.	14th.
Cutch.						*Hyderabad*—contd.					
Bhuj	0·21	1·05	4·63	0·99	1·35	Naushalro	...	0·41	...	...	...
Karachi.						Badin	...	0·12	1·15	1·10	0·10
Karachi	...	...	...	0·44	0·65	Shahadadpur	...	...	0·37	0·01	...
Manora	...	...	...	1·35	...	Sakrand	...	...	0·87	0·16	...
Dadu	...	...	...	...	...	*Thar and Parker.*					
Johi	...	...	...	...	...	Umerkot	...	...	1·69	0·12	0·50
Sehwan	...	...	...	...	...	Khipra	...	...	1·80	0·09	...
Manjhand	...	...	0·57	0·53	...	Mittu	0·15	...	0·48	...	1·16
Kotri	...	...	0·30	0·25	...	Nagar Parker	...	0·21	0·34	...	3·00
Balakhan	...	...	0·20	0·32	...	*Khandesh.*					
Tatta	...	...	0·76	0·44	...	Dhulia	0·84	0·27	0·08	...	...
Jerruch	...	...	0·78	...	...	Amelner	0·8	0·47	0·20	...	...
Sakro	...	...	0·95	1·67	...	Parola	0·02	0·07	...	...	...
Kotri Ghorabari	...	0·77	0·45	1·60	...	Erandol	0·03	0·14	0·06	...	...
Keti Bandar	...	...	1·22	1·42	...	Pachora	0·06	0·13	0·07	...	0·05
Mirpore Batoro	...	...	0·30	0·15	0·35	Bhadgaon	...	...	...	0·03	...
Sujaval	...	0·70	0·50	...	...	Chalisgaon	...	0·10	...	...	0·20
Mugalbin	...	...	0·35	1·02	0·06	Pimpalner	0·18	0·20	0·28	0·08	0·23
Shahbandar	...	...	1·10	2·30	0·41	Nizampur	0·07	0·28	0·07	0·07	0·14
Hyderabad.						Nundarbar	0·07	0·36	1·32	0·38	0·19
Tanda Mahomed Khan	0·10	...	0·91	0·43	0·92	Taloda	0·33	0·50	1·00	0·47	0·66
Tando Bago	0·07	0·07	1·47	0·31	0·03	Shahada	0·21	0·17	0·85	0·12	0·20
Hala	...	...	0·51	0·05	...	Sindkhed	0·64	...	0·90	0·02	...
Tando Adam	...	...	0·82	...	...	Shirpur	0·34	0·58	0·24	0·03	...
Tanda Alyar	...	...	2·13	...	...	Chopda	2·59	0·25	0·33	0·05	0·10
Tharushah	...	0·42	...	...	...	Savda	0·12	0·50	0·40	...	0·03
Mirpur Khas	...	...	2·75	...	...	Javel	1·40	0·75	0·20	...	...
Hyderabad	...	...	0·48	0·09	...	Raver	0·28	0·38	0·25	...	...
Kandiaro	...	0·04	0·03	...	...	Bhusaval	0·50	0·09	0·08	...	0·11
Digri	...	...	1·90	...	...	Edalabad	0·27	...	...	...	0·15
Moro	...	...	...	...	...	Jalgaon	0·07	0·69	0·12	...	0·04
						Jamner	0·09	0·32	0·06	...	...

Statement giving the daily rainfall at stations in the districts enumerated.—concluded.

Stations.	July 1881.					Stations.	July 1881.				
	10th.	11th.	12th.	13th.	14th.		10th.	11th.	12th.	13th.	14th.
Surat.						*Ahmedabad.*					
Olpad . . .	1·08	4·20	0·16	0·56	1·47	Dholka . . .	1·90	4·92	0·14	0·80	0·25
Randeir . . .	0·16	2·46	2·30	0·28	0·58	Dhundhuka . .	0·04	1·85	0·30	0·14	0·62
Valod . . .	1·10	4·67	1·88	0·23	0·84	Dhollera . . .	0·80	2·00	0·20	0·41	0·66
Bardoli . . .	1·17	2·99	1·71	0·64	0·63	Sanand . . .	1·28	2·34	0·71	0·12	0·71
Kaliawadi . . .	0·83	4·30	0·90	0·53	1·15	Viramgaum . .	0·22	3·41	3·40	0·18	0·95
Chikhli . . .	2·20	3·79	1·21	0·85	1·20	Parantij . . .	0·04	4·91	1·15	0·53	1·43
Bulsar . . .	4·96	4·27	0·87	0·30	0·54	Ahmedabad . .	0·88	2·80	1·35	0·47	1·21
Pardi . . .	6·96	4·84	0·17	0·25	0·30	Kharaghoda . .	0·07	0·48	2·53	0·01	0·68
Mandvi . . .	0·96	2·90	2·50	0·63	0·66	*Rewakanta.*					
Broach.						Rajpipla . . .	0·80	1·47	0·56	0·51	0·12
Jambusar . . .	0·51	11·75	0·22	0·35	0·17	Chotta Udeypur . .	1·52	0·80	0·56	0·59	1·15
Amod . . .	1·28	11·35	0·44	0·51	0·24	Baria . . .	0·11	1·29	2·12	0·74	0·80
Wagra . . .	0·75	...	0·05	0·53	1·25	Lunawara . . .	0·28	0·60	2·80	0·30	0·63
Broach . . .	0·52	7·64	0·12	0·65	0·45	Sunth . . .	0·00	1·10	2·05	0·40	0·70
Ankleshvar . .	1·20	6·41	...	0·26	0·84	Balasinor . . .	0·54	2·16	1·13	1·27	0·63
Kaira.						Wadia . . .	2·40	2·10	0·60	0·12	0·48
Thasra . . .	0·20	2·40	0·90	1·00	0·50	Pandu . . .	1·40	1·80	1·00	0·28	0·88
Kapadvanj . . .	0·29	8·08	1·38	0·50	1·19	Dodka . . .	0·50	9·25	0·82	0·20	0·60
Nariad . . .	2·23	2·76	1·06	0·62	0·73						
Kaira . . .	1·23	3·45	1·65	1·11	0·80	*Mahikanta.*					
Dakore . . .	0·90	6·10	2·10	0·86	0·60	Sadra . . .	0·25	2·33	0·76	0·87	3·62
Matur . . .	1·70	2·86	2·65	0·02	1·05	Edar . . .	3·78	3·31	0·72	0·86	1·36
Anand . . .	1·15	0·30	9·40	0·30	0·90	Gadhwara . . .	0·39	2·31	0·64	0·85	1·10
Memdabad . . .	2·62	2·66	0·82	0·98	0·54	Katosan . . .	1·20	0·76	2·40	1·23	0·35
Borsad . . .	1·12	9·12	1·12	0·85	0·76	Samlaji . . .	2·42	0·50	1·17	0·87	1·30
Panch Mahals.						Posina . . .	1·07	...	0·10	1·31	1·15
Godhra . . .	0·85	0·92	1·92	0·88	2·28	Pol	0·30	1·05	0·80	1·30	3·50
Dohad . . .	0·61	0·82	1·10	0·27	0·58	*Palanpur.*					
Jhalod . . .	0·70	6·45	0·83	0·40	0·70	Palanpur . . .	1·28	1·28	0·22	0·50	1·33
Kalol . . .	3·04	1·24	0·84	1·10	0·67	Santalpur . . .	0·67	1·70	...	0·20	5·00
Halol . . .	4·70	3·90	1·60	1·05	0·85	Tharad . . .	0·40	0·93	0·12	0·06	0·91
Jambughora .	4·08	1·52	1·97	0·32	2·52						

IV.—On the Temperature of North-Western India :—By S. A. Hill, B.Sc., *Meteorological Reporter to Government, North-Western Provinces and Oudh.*

Nearly eight years having now elapsed since the establishment of the Indian Meteorological Department, while, in all the more important provinces, local arrangements for the collection and publication of trustworthy meteorological observations were made eight or ten years previously, the time has now arrived when it may fairly be assumed that normal values of the temperature and other climatological elements, for most parts of the country, are attainable. But if one may judge from the maps given in modern text-books of physical geography and meteorology, the prevailing notions regarding the distribution of temperature and barometric pressure in India are still very inaccurate. This paper has therefore been compiled with the object of correcting these ideas as regards temperature; but since the labour of working out the normal temperatures for the whole of India and Burma would be very great, and since I have no personal knowledge of Southern and Eastern India, I have confined the scope of the present paper to the North-West; including, under this term, all those portions of the Indian area, which lie north of the 20th parallel and west of the meridian of 86°E. from Greenwich.

The discussion of the temperature of the rest of the country is better left to other officers of the Meteorological Department, and moreover, it will be most satisfactorily performed after the reduction of the observations collected from the Indian Seas, now, I believe, in progress.

In this paper, we have to deal with a land area equal to that of Central Europe,—that is, to the whole of Europe with the exception of Russia and the Scandinavian, Balkan, and Iberian peninsulas—in which, up to the present time, temperature observations of the following classes have been made :—*

I. Observations of a standard or verified thermometer, under a thatched shed, for several years, at 4, 10, 16, and 22 hours, local time; or at 10 and 16 hours only, together with hourly observations on four complete days in each month, and daily observations of the self-recorded maxima and minima.

II. Observations of the state of the thermometer at 10 and 16 hours and of the maxima and minima only; the instruments, however, being exposed under thatched sheds, and being for the most part verified and corrected.

III. Observations of a somewhat desultory and uncertain kind, made at hospitals and dispensaries or by private observers, the thermometer being unverified and the exposure various; the hours of observation also various, but most frequently sunrise and 4 P.M.

In the map which gives the normal distribution of the mean annual temperature [Plate XIV], the stations, at which the three classes of observations have been taken, are distinguished by different signs. Those of the first and second class are furnished by the Government observatories and a few others equipped on the same scale. From the numerous observations of the third class, a selection has been made; none being taken, unless they agreed fairly with the nearest of Class I or II, or unless they belonged to some region not otherwise represented.

Observations of the third class, made in earlier years have, however, in many instances been used to extend the register of the present meteorological observatories; the annual

* At the Maharaja's Observatory, Jaipur, the temperature is now automatically recorded by one of Van Rysselberghe's Meteorographs, but none of the traces have yet been tabulated.

means of the two series, in such cases, differing by less than the probable error of the mean.

Diurnal Variation.

The first step towards the establishment of the normal temperature of a place, is the determination of the daily variation, and the correction which must be applied to the mean founded on any given combination of hours, in order to reduce it to the true diurnal mean. For the purpose of determining such corrections, the hourly observations, mentioned above, were instituted in 1875 and 1876, and are still being carried on. On each term day, (the 7th, 14th, 21st and 28th of the month), twenty-five observations of temperature, extending from midnight to midnight, are made.

All the hourly observations, for any given month, having been tabulated and the means struck, and any residual difference between the two midnight means having been distributed equally, the observations at 4, 10, 16 and 22 hours (when such had been taken) were inserted and the figures altered accordingly, as described in Volume I, page 63: The figures for the day hours were then in some cases further corrected by means of a longer series of observations at 10 and 16 hours. In this way were obtained the corrected hourly means and the true diurnal mean for each month.

Table I gives the variations from the diurnal mean, at 4, 10, 16 and 22 hours, for every station at which hourly observations have been recorded; also the daily extremes, as given by self-registering thermometers; and the periodic maxima and minima, with the hours at which they occur. The periodic extremes have been obtained, by parabolic interpolation, from the observations of the three hours nearest to the maximum or minimum; the epoch of the minimum, at least, being determined more exactly by this method than by means of Bessel's formula. The data in the table will suffice for the graphic reconstruction of the diurnal curves, and they occupy much less space in printing than the full series of hourly values would have done.

For several stations, at which no hourly observations were made, approximate values of the hourly means have been obtained, by inserting the observations made at 4, 10, 16 and 22 hours at these stations, in the hourly series for some station or stations not very distant, and correcting the other figures accordingly. The data on which the diurnal curves for each place are founded, are mentioned in the heading of each table.

No regular series of hourly readings having been made at any of the Himalayan stations of 6,000 or 7,000 feet elevation,* I have attempted to construct hourly curves for Chakráta and Ránikhet, by parabolic interpolation between the 4 A.M., minimum and 10 A.M. observations, the 10 A.M. maximum and 4 P.M. observations, and the 4 P.M. 10 P.M. and 4 A.M. observations. The extreme values being those given by self-registering thermometers, the range of the curves is too great; but the epochs of minimum and maximum are probably not far wrong; and the calculated hourly values suffice to show that, the mean of the four equidistant observations, at 4, 10, 16 and 22 hours, does not differ, in any month, by more than 0·2° from the mean of the day—a conclusion which is confirmed by occasional series of observations made by travellers, for example, by Dr. Scully's Series at Murree and Srinagar, given in Volume I, page 224 of this serial; and which might indeed be inferred from the small diurnal range at these elevations. For hill stations between 5,000 and 8,000 feet, we may therefore assume the mean of four equidistant observations to be the true mean of the day.

* Except those by Colonel Boileau, at Simla, in the years 1843 to 1845; and, in this case, the conditions of exposure were such, as to render them not comparable with the temperature readings now recorded at the Government Observatories.

H. F B.

TABLE I.—*Diurnal variation of Temperature.*

STATION: LEH.

Latitude, 34° 10′ N.; Longitude, 77° 42′ E.; Elevation, 11,538 feet.

Data— Hourly observations . . . . 12 days each month.
Maxima and Minima 4—5 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	A periodic Maximum.*	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	− 8·9	+6·7	+ 7·9	−3·7	+11·6	− 9·6	13 33	5 15	+13·4	−10·1	23·5
February . .	− 8·7	+7·1	+ 7·2	−3·6	+10·6	−10·1	13 37	5 31	+11·6	−12·0	23·6
March . .	− 8·0	+3·9	+ 8·7	−3·2	+10·5	− 8·8	13 30	4 57	+11·0	−10·9	21·9
April . .	− 9·2	+5·2	+ 7·9	−3·6	+10·2	−10·3	13 30	4 43	+12·8	−12·9	25·7
May . . .	−11·0	+5·1	+ 9·9	−4·5	+12·5	−11·8	14 34	4 37	+14·1	−12·6	26·7
June . .	−11·3	+3·6	+12·3	−4·9	+12·3	−12·1	15 26	4 38	+14·5	−12·7	27·2
July . .	−10·1	+1·4	+12·3	−3·8	+13·3	−11·1	14 20	4 44	+15·7	−11·7	27·4
August . .	−10·2	+3·8	+10·7	−3·8	+12·1	−10·7	14 14	4 38	+13·7	−11·7	25·4
September . .	−10·2	+5·3	+10·1	−4·6	+12·9	−11·1	13 42	4 41	+14·0	−13·1	27·1
October . .	− 9·4	+4·5	+ 8·8	−3·4	+12·0	−10·2	13 21	4 55	+13·1	−13·0	26·1
November . .	− 8·7	+5·3	+ 8·7	−3·5	+11·7	− 9·8	13 15	5 17	+12·7	−12·1	24·8
December . .	− 8·9	+5·5	+ 8·7	−2·9	+11·2	− 9·9	13 56	5 30	+12·0	−10·7	22·7
Year .	− 9·6	+4·8	+ 9·4	−3·8	+11·7	−10·5	13 55	4 57	+13·2	−12·0	25·2

* The thermometer in use having given erroneous readings, these figures have been taken from the hourly observations. They represent the mean excess of the highest hourly reading above the mean of the day.

STATION: CHAKRÁTA.

Latitude, 30° 40′ N.; Longitude, 77° 55′ E.; Elevation, 7,052 feet.

Data— Six hourly observations . . . . 5—6 years.
10 hours and 16 hours observations . . 6 additional years.
Maxima and Minima . . . . 11—12 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−4·4	+3·9	+2·8	−2·5	12 53	5 22	+ 9·9	−5·4	15·3
February .	−4·4	+3·2	+3·6	−2·4	13 3	5 34	+ 9·6	−5·5	15·1
March . .	−5·3	+3·8	+4·0	−2·8	13 4	5 47	+ 9·8	−7·3	17·1
April . .	−6·7	+4·9	+5·4	−3·6	13 4	5 21	+10·1	−7·8	17·9
May . .	−6·3	+5·0	+5·3	−3·8	13 3	5 16	+ 9·3	−8·1	17·4
June . .	−5·4	+3·9	+4·1	−2·6	13 0	5 40	+ 8·0	−7·1	15·1
July . .	−3·3	+2·4	+2·2	−1·3	12 58	5 44	+ 5·9	−4·5	10·4
August . .	−2·9	+2·5	+1·8	−1·5	12 51	5 42	+ 5·5	−3·9	9·4
September .	−3·4	+3·0	+2·5	−2·0	12 54	5 30	+ 6·8	−4·2	11·0
October . .	−5·2	+4·8	+3·7	−3·3	12 49	5 13	+ 8·7	−5·9	14·6
November .	−5·3	+5·4	+3·3	−3·6	12 41	5 8	+ 9·4	−5·9	15·3
December .	−4·4	+4·5	+2·3	−2·4	12 45	5 42	+10·1	−5·6	15·7
Year .	−4·7	+3·9	+3·4	−2·7	12 55	5 30	+ 8·6	−6·0	14·5

TABLE I.—*Diurnal Variation of Temperature*—contd.

STATION: RÁNIKHET.

Latitude, 29° 38 N.; Longitude, 79° 29′ E.; Elevation 6,069 feet.

Data—
Six hourly observations . . . . . 4—5 years.
10 hours and 16 hours . . . . . 6 additional years.
Maxima and Minima . . . . . 10—11 years.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−5·0	+2·4	+4·8	−2·3	13 21	5 40	+8·9	−6·3	15·2
February .	−4·9	+1·8	+5·1	−2·3	13 32	6 0	+8·2	−7·1	15·3
March . .	−5·3	+2·8	+5·5	−2·9	13 25	6 1	+9·2	−8·1	17·3
April . .	−5·3	+3·3	+5·3	−3·3	13 24	6 7	+8·4	−9·0	17·4
May . .	−5·4	+3·6	+4·9	−2·9	13 13	6 0	+8·7	−8·4	17·1
June . .	−5·3	+2·3	+4·6	−1·6	13 22	5 39	+7·2	−6·6	13·8
July . . .	−3·9	+1·6	+3·2	−1·1	13 20	5 35	+6·0	−4·7	10·7
August . .	−3·2	+1·5	+3·1	−1·4	13 23	5 42	+5·5	−3·8	9·3
September .	−4·1	+2·5	+4·1	−2·5	13 19	5 36	+7·2	−5·1	12·3
October . .	−5·3	+3·1	+5·7	−3·5	13 28	5 31	+8·5	−6·4	14·9
November .	−5·7	+3·2	+5·2	−2·8	13 19	5 46	+8·9	−7·4	16·3
December .	−5·1	+2·4	+4·3	−2·4	13 17	5 53	+8·8	−7·1	15·6
Year .	−4·9	+2·5	+4·7	−2·4	13 22	5 47	+8·0	−6·6	14·6

STATION: LAHORE.

Latitude, 31° 34′ N.; Longitude, 74° 20′ E.; Elevation 732 feet.

Data.—
Hourly observations . . . . . 20 days each month.
Six hourly ,, ... 5 years.
Maxima and Minima . . . . . 5 ,,

Month.	4 hours	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	− 9·2	+3·3	+13·1	−3·8	+13·6	−10·0	14 53	6 30	+15·4	−12·0	27·4
February . .	− 8·6	+3·0	+11·3	−3·4	+11·9	− 9·3	14 57	5 50	+13·3	−11·2	24·5
March . .	−10·1	+4·0	+12·1	−3·8	+12·7	−12·0	14 40	5 49	+14·2	−12·7	26·9
April . .	−12·2	+5·5	+12·7	−5·4	+13·1	−12·5	14 29	5 50	+15·5	−14·8	30·3
May . .	−12·0	+5·2	+12·1	−5·0	+12·7	−12·2	14 28	4 34	+14·9	−14·1	29·0
June . . .	−10·6	+4·3	+11·4	−4·4	+12·6	−11·1	14 5	4 49	+14·8	−12·4	27·2
July . .	− 7·0	+2·0	+ 7·4	−2·6	+ 8·2	− 7·3	14 15	4 55	+11·0	− 8·5	19·5
August . .	− 6·3	+2·6	+ 6·5	−2·5	+ 7·1	− 6·7	14 42	5 0	+10·1	− 7·8	17·9
September .	− 7·8	+3·9	+ 9·0	−3·6	+ 9·4	− 8·9	14 30	5 39	+10·9	− 9·6	20·5
October . .	−10·6	+5·8	+13·1	−5·3	+13·9	−11·3	14 55	5 42	+15·4	−12·8	28·2
November .	− 9·5	+6·5	+14·1	−6·1	+15·6	−11·2	14 30	6 4	+17·4	−13·0	30·4
December .	− 9·0	+4·3	+13·0	−4·9	+14·4	−10·4	14 44	6 37	+16·0	−11·9	27·9
Year .	− 9·4	+4·2	+11·3	−4·2	+12·1	−10·2	14 36	5 37	+14·1	−11·7	25·8

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: KURRACHEE.

Latitude, 24° 47′ N.; Longitude, 67° 4′ E.; Elevation 49 feet.

Data— Hourly observations, 15-18 days each month. Maxima and Minima, 18 years. } From the *Meteorology of the Bombay Presidency* by C. CHAMBERS, F.R.S.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.*	Self-registered Minimum.*	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	— 7·9	+3·6	+ 9·9	−2·3	+10·4	— 9·7	14 25	6 10	+13·0	−11·3	24·3
February	— 8·7	+4·5	+ 9·8	−3·2	+10·5	−10·3	14 15	5 58	+13·7	−10·8	24·5
March	— 6·7	+4·8	+ 6·5	−1·8	+ 7·9	— 8·7	12 36	5 52	+12·2	−10·1	22·3
April	— 6·4	+4·9	+ 5·4	−3·0	+ 8·1	— 7·0	12 56	4 51	+11·7	— 7·5	19·2
May	— 4·9	+3·4	+ 4·5	−2·5	+ 5·6	— 5·1	13 45	4 35	+10·9	— 5·1	16·0
June	— 3·7	+3·5	+ 3·3	−2·0	+ 4·6	— 4·1	13 30	4 52	+ 9·0	— 4·4	13·4
July	— 2·3	+2·1	+ 2·3	−1·5	+ 4·1	— 2·6	12 48	4 56	+ 7·0	— 4·2	11·2
August	— 2·7	+2·0	+ 3·1	−1·4	+ 4·3	— 3·0	13 30	5 43	+ 7·3	— 3·1	10·4
September	— 3·6	+3·1	+ 3·6	−1·8	+ 5·1	— 4·1	13 30	5 23	+ 8·1	— 4·9	13·0
October	— 9·5	+4·9	+10·0	−3·1	+11·7	−10·4	13 55	5 36	+13·7	— 7·9	21·6
November	−10·7	+6·8	+11·0	−3·1	+12·5	— 12·2	14 0	5 40	+16·4	−11·0	27·4
December	— 7·9	+4·3	+ 9·8	−2·2	+10·6	−10·7	14 18	6 19	+14·2	−12·0	26·2
Year	— 6·3	+4·0	+ 6·6	−2·3	+ 8·0	— 7·3	13 37	5 29	+11·4	— 7·7	19·1

* Thermometers uncorrected, minimum doubtful.

STATION: DEESA.

Latitude, 24° 16′ N.; Longitude, 72° 14′ E. Elevation, 166 feet.

Data— Hourly observations, 13-17 days each month. Maxima and Minima, 18 years. } From the *Meteorology of the Bombay Presidency* by C. CHAMBERS, F.R.S.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.*	Self-registered Minimum.*	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	−11·5	+4·6	+13·3	−3·3	+14·5	−13·1	14 39	6 12	+15·1	−15·7	30·8
February	−12·6	+4·8	+14·1	−2·2	+14·6	−16·0	14 57	6 18	+14·6	−16·6	31·2
March	−12·9	+4·6	+13·1	−2·4	+14·0	−14·5	14 50	5 38	+15·6	−15·5	31·1
April	−11·9	+2·5	+12·1	−0·9	+12·7	−15·2	15 0	5 52	+13·6	−17·1	30·7
May	— 9·9	0·0	+11·5	−0·6	+11·7	−11·7	15 18	5 44	+12·9	−14·1	27·0
June	— 6·3	+0·3	+ 7·8	−1·7	+ 8·0	— 7·0	15 18	4 49	+11·1	— 9·7	20·8
July	— 3·5	+0·7	+ 4·4	−0·6	+ 4·6	— 4·1	15 9	5 46	+ 7·4	— 6·9	14·3
August	— 3·5	+0·6	+ 4·2	−0·8	+ 4·3	— 4·0	15 0	5 39	+ 6·3	— 5·5	11·8
September	— 6·4	+2·0	+ 7·4	−1·5	+ 7·9	— 7·2	15 0	5 36	+ 9·3	— 7·1	16·4
October	−12·9	+6·8	+12·7	−4·4	+13·9	−14·1	14 0	5 56	+14·9	−13·2	28·1
November	−13·1	+7·9	+12·9	−4·0	+14·8	−13·7	14 0	5 3	+16·2	−16·9	33·1
December	−10·4	+6·0	+12·9	−3·7	+14·4	−12·8	14 3	6 6	+15·2	−17·0	32·2
Year	— 9·6	+3·4	+10·5	−2·2	+11·3	−11·1	14 46	5 43	+12·7	−12·9	25·6

* Thermometers uncorrected, minimum doubtful.

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: AJMERE.

Latitude, 26° 26′ N.; Longitude, 74° 37′ E.; Elevation 1,611 feet.

Data—
Hourly observations . . . . . 24 days each month (at Agra).
Six hourly „ . . . . . 8—9 years.
10 hours and 16 hours observations . . 6 years (in addition).
Maxima and Minima . . . . . 7—14 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−12·7	+ 7·4	+15·0	−5·6	+15·8	−13·9	14 42	5 9	+15·9	−14·5	32·4
February . .	−11·8	+ 6·0	+13·3	−4·7	+14·4	−13·2	14 30	5 16	+15·9	−15·2	31·2
March . .	−12·5	+ 7·4	+13·3	−5·2	+14·2	−13·8	14 30	5 9	+16·8	−16·0	32·8
April . .	−12·1	+ 7·3	+12·6	−4·9	+13·5	−13·0	14 21	5 4	+15·2	−16·2	31·4
May . .	−11·3	+ 5·1	+12·1	−3·8	+12·4	−10·6	14 37	5 0	+15·0	−13·6	28·6
June . .	− 8·5	+ 2·8	+10·0	−3·4	+10·1	− 9·0	14 42	5 0	+12·8	− 9·8	22·6
July . .	− 5·0	+ 1·8	+ 7·1	−2·2	+ 7·4	− 6·2	14 40	4 48	+10·0	− 6·6	16·6
August . .	− 6·1	+ 1·9	+ 6·9	−2·6	+ 7·8	− 6·4	14 37	4 30	+ 8·3	− 6·6	14·9
September . .	− 7·7	+ 3·6	+ 8·5	−4·3	+10·1	− 7·9	14 23	4 38	+10·9	− 8·9	19·8
October . .	−13·0	+ 9·6	+14·1	−7·6	+15·4	−13·1	14 4	4 26	+16·4	−14·0	30·4
November .	−14·9	+10·9	+15·9	−7·2	+17·5	−15·2	13 54	4 35	+19·2	−15·6	34·8
December .	−13·1	+ 7·8	+14·3	−5·5	+15·7	−13·6	14 19	4 47	+18·3	−15·1	33·4
Year .	−10·7	+ 6·0	+11·9	−4·8	+12·9	−11·3	14 27	4 52*	+14·6	−12·7	27·4

* The unusually early hour of the daily minimum at this station may perhaps be attributed to the peculiar position of the observatory, which was formerly situated at the foot of a rocky ridge, near an opening in the ridge through which the air, cooled by nocturnal radiation, drained away. In the present situation of the observatory near the centre of the plateau, the minimum probably occurs later.

STATION: JEYPUR.

Latitude, 26° 54′ N.; Longitude 75° 49′ E.; Elevation 1,430 feet.

Data.—
Hourly observations . . . . . 4 days each month.
Six hourly „ . . . . . 1 year.
Maxima and Minima . . . . . 1 „ .

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M	°	°	°
January . .	− 9·1	+ 7·3	+14·3	−5·3	+14·9	−12·8	14 45	6 41	+16·5	−12·8	29·3
February . .	−11·3	+ 8·0	+13·3	−6·3	+15·2	−13·4	13 54	5 37	+16·0	−14·6	30·6
March . .	− 9·1	+ 4·6	+11·8	−4·5	+12·8	−10·7	14 17	5 30	+14·1	−12·8	26·9
April . .	−11·6	+ 5·8	+12·3	−5·4	+13·1	−14·1	14 27	5 31	+14·6	−14·6	29·2
May . .	−11·6	+ 5·9	+11·6	−4·6	+13·9	−13·3	14 7	5 25	+15·6	−13·9	29·5
June . .	− 8·3	+ 1·8	+ 8·4	−3·8	+ 9·7	− 9·7	14 43	5 2	+11·8	−10·0	21·8
July . .	− 3·9	+ 1·3	+ 4·7	−1·6	+ 5·2	− 4·0	14 42	4 50	+ 8·4	− 5·4	13·8
August . .	− 3·9	+ 1·3	+ 4·7	−1·7	+ 6·5	− 4·0	14 34	5 0	+ 7·7	− 4·9	12·6
September . .	− 6·7	+ 2·6	+ 8·0	−3·0	+ 8·4	− 7·4	14 30	5 37	+10·5	− 8·0	18·5
October . .	−10·7	+ 7·0	+13·5	−6·0	+14·6	−11·6	14 12	5 39	+16·1	−12·7	28·8
November .	−13·4	+13·0	+16·5	−6·9	+18·0	−15·2	14 4	6 19	+19·2	−15·8	35·0
December .	− 9·8	+ 7·7	+14·4	−5·7	+15·7	−10·3	14 54	6 34	+16·7	−12·9	29·6
Year .	− 9·1	+ 5·5	+11·1	−4·6	+12·3	−10·5	14 26	5 39	+13·9	−11·5	25·5

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: ROORKEE.

Latitude, 29° 52′ N.; Longitude, 77° 56′ E.; Elevation, 887 feet.

Data—

Hourly observations . . . . 24 days each month.
Six hourly ,, ... 7-8 years (in addition).
10 & 16 hours observations . . . 5-6 ,,
Maxima and Minima . . . . 14 ,,

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	— 9·4	+2·3	+11·8	—2·7	+13·1	—10·9	14 30	6 43	+14·6	—12·3	26·9
February . .	— 9·2	+3·0	+11·4	—3·2	+12·6	—10·6	14 30	6 30	+14·0	—11·6	25·6
March . .	—11·2	+5·1	+12·6	—4·0	+13·5	—12·2	14 30	5 46	+15·2	—13·8	29·0
April . .	—12·9	+6·7	+12·9	—4·4	+13·7	—13·5	14 36	5 15	+15·6	—15·5	31·1
May . . .	—12·4	+5·7	+12·0	—3·8	+12·5	—13·2	14 45	5 0	+14·7	—14·0	28·7
June . .	— 8·7	+2·8	+ 8·9	—2·7	+10·0	— 9·6	14 30	5 6	+11·8	—10·7	22·5
July . . .	— 5·0	+1·3	+ 5·4	—1·6	+ 5·6	— 5·6	15 30	5 3	+ 8·2	— 6·3	14·5
August . .	— 4·9	+2·1	+ 6·1	—1·8	+ 6·2	— 5·4	15 20	5 10	+ 7·9	— 5·8	13·7
September . .	— 6·7	+3·3	+ 7·3	—3·1	+ 8·6	— 7·5	14 0	5 37	+10·1	— 8·2	18·3
October . .	—10·4	+6·6	+12·3	—4·8	+14·3	—11·5	14 30	6 3	+15·2	—12·9	28·1
November . .	—12·4	+7·4	+14·1	—5·5	+16·7	—12·8	14 10	6 0	+18·1	—14·7	32·8
December . .	— 9·8	+4·5	+12·4	—4·2	+14·7	—10·7	14 30	6 30	+16·5	—12·7	29·2
Year .	— 9·4	+4·2	+10·6	—3·5	+11·8	—10·3	14 37	5 44	+13·5	—11·5	25·0

STATION: AGRA.

Latitude, 27° 10′ N.; Longitude, 78° 5′ E.; Elevation, 555 feet.

Data—

Hourly observations . . . . 24 days each month.
Six hourly ,, ... 7-8 years.
10 & 16 hours observations . . . 5-6 ,, (in addition).
Maxima and Minima . . . . 12-14 ,,

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	— 6·7	+1·3	+10·8	—1·2	+11·6	—10·9	14 45	6 46	+12·8	—10·9	23·7
February . .	— 8·6	+1·3	+11·4	—1·4	+11·6	—11·8	15 1	6 31	+13·2	—11·8	25·0
March . .	— 9·9	+2·9	+12·7	—1·2	+13·0	—12·6	15 33	5 59	+14·6	—12·6	27·2
April . .	—10·6	+3·4	+11·8	—2·0	+12·0	—13·0	15 33	5 43	+13·9	—13·7	27·6
May . . .	— 9·5	+3·0	+10·1	—2·2	+10·5	—10·7	15 14	5 26	+12·9	—12·2	25·1
June . .	— 6·7	+2·0	+ 7·1	—1·5	+ 7·5	— 8·0	14 36	5 27	+10·1	— 8·9	19·0
July . .	— 3·7	+0·9	+ 3·9	—0·8	+ 4·7	— 3·4	13 57	5 31	+ 5·4	— 5·9	11·3
August . .	— 3·5	+0·6	+ 3·6	—0·7	+ 5·0	— 4·8	14 14	5 42	+ 5·9	— 5·8	11·7
September . .	— 4·3	+1·4	+ 5·0	—1·2	+ 5·4	— 5·7	14 57	5 52	+ 6·9	— 6·5	13·4
October . .	— 7·4	+2·2	+10·4	—2·5	+10·2	—10·0	14 38	6 19	+11·8	—10·6	22·4
November . .	— 9·6	+3·3	+12·7	—2·7	+13·3	—11·7	15 22	6 23	+14·0	—12·5	26·5
December . .	— 7·6	+2·0	+10·9	—1·4	+11·4	—10·7	14 51	6 40	+12·5	—11·6	24·1
Year .	— 7·3	+2·0	+ 9·2	—1·6	+ 9·7	— 9·5	14 54	6 2	+11·2	—10·3	21·4

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: JHANSI.

Latitude, 25° 27′ N.; Longitude, 78° 37′ E.; Elevation, 855 feet.

Data.—
Hourly observations of Agra, Allahabad and Jubbulpore.
Six hourly ,, . . . 6-7 years.
10 & 16 hours observations . . 7 additional years.
Maxima and Minima . . . 14 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	− 9·7	+ 3·2	+11·1	− 0·9	+12·2	−11·7	14 30	6 32	+13·5	−12·5	26·0
February . .	−10·8	+ 3·3	+11·5	− 1·1	+12·6	−12·6	14 35	6 5	+13·0	−12·6	26·6
March . .	−11·3	+ 4·1	+12·2	− 1·3	+12·7	−13·7	14 38	5 43	+14·6	−13·7	28·3
April . .	−11·6	+ 4·8	+11·8	− 2·2	+12·5	−13·6	14 40	5 37	+14·7	−13·5	28·2
May . .	−10·5	+ 3·7	+10·0	− 2·3	+10·7	−11·6	14 13	5 25	+13·6	−12·8	26·4
June . .	− 5·9	+ 2·4	+ 6·3	− 1·9	+ 7·8	− 6·8	14 10	5 37	+12·0	− 9·0	21·0
July . .	− 3·8	+ 1·3	+ 4·5	− 1·2	+ 5·1	− 4·5	14 15	5 35	+ 8·6	− 5·2	13·8
August . .	− 4·0	+ 2·1	+ 3·8	− 1·5	+ 5·3	− 4·4	14 0	5 24	+ 7·6	− 5·6	13·2
September .	− 6·0	+ 3·1	+ 6·3	− 2·1	+ 7·1	− 6·4	14 4	5 33	+ 8·7	− 6·7	15·4
October . .	−10·7	+ 5·7	+ 9·9	− 1·6	+11·5	−11·6	14 6	5 30	+12·8	−12·0	24·8
November .	−11·8	+ 6·8	+11·8	− 0·5	+13·8	−13·4	13 58	5 41	+14·7	−14·1	28·8
December . .	−11·9	+ 5·1	+11·0	− 0·2	+13·2	−12·5	13 54	6 0	+13·6	−12·9	26·5
Year .	− 9·0	+ 3·8	+ 9·2	− 1·4	+10·4	−10·2	14 15	5 44	+12·3	−10·9	23·3

STATION: LUCKNOW.

Latitude, 26° 50′ N.; Longitude, 81° 0′ E.; Elevation, 369 feet.

Data.—
Hourly observations . . . 24 days each month.
Six hourly ,, . . . 7-8 years.
10 & 16 hours observations . . 6 additional years.
Maxima and Minima . . . 13 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−10·2	+ 2·8	+11·2	− 3·8	+12·4	−13·4	14 43	6 40	+13·7	−15·2	28·9
February . .	−10·8	+ 4·1	+13·1	− 2·8	+13·1	−12·2	15 0	6 4	+14·6	−14·5	29·1
March . .	−12·4	+ 5·8	+13·5	− 2·6	+14·0	−14·0	14 40	5 42	+15·6	−16·1	31·7
April . .	−13·4	+ 6·4	+12·9	− 4·3	+13·9	−14·7	14 45	5 29	+15·6	−16·8	32·4
May . .	−10·8	+ 4·0	+11·0	− 2·5	+11·4	−11·5	15 7	5 0	+13·9	−13·7	27·6
June . .	− 9·0	+ 2·4	+ 7·8	− 1·9	+ 8·3	− 8·6	14 30	5 6	+11·3	−10·4	21·7
July . .	− 4·2	+ 2·0	+ 4·9	− 1·5	+ 5·6	− 4·7	14 4	5 35	+ 8·4	− 6·0	14·4
August . .	− 4·3	+ 1·6	+ 4·8	− 1·6	+ 5·7	− 4·9	13 48	5 38	+ 7·5	− 6·0	13·5
September .	− 4·8	+ 3·0	+ 5·2	− 1·9	+ 6·2	− 5·8	13 54	5 38	+ 8·8	− 7·0	15·8
October . .	− 9·8	+ 6·2	+11·1	− 4·2	+12·1	−11·3	14 8	5 42	+14·0	−12·4	26·4
November .	−11·8	+ 7·3	+14·0	− 5·1	+15·8	−12·7	14 20	5 43	+17·3	−15·7	33·0
December . .	−10·6	+ 5·9	+13·5	− 3·9	+15·2	−12·7	14 27	6 21	+17·0	−14·4	31·4
Year .	− 9·3	+ 4·3	+10·3	− 3·1	+11·1	−10·5	14 27	5 43	+13·1	−12·4	25·5

TABLE I—*Diurnal variation of Temperature*—contd.

STATION: ALLAHABAD.

Latitude, 25° 26′ N.; Longitude, 81° 52′ E.: Elevation, 307 feet.
Data—
Hourly observations. 24 days each month.
Six hourly ,, . 12 years.
Maxima and Minima. 12 ,,

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	− 9·4	+ 4·0	+12·3	− 3·3	+14·0	−10·5	14 13	6 46	+14·8	−11·5	26·3
February . .	−11·0	+ 4·9	+13·5	− 4·1	+14·5	−12·5	14 10	6 5	+15·8	−13·0	28·8
March . .	−12·5	+ 6·5	+14·0	− 4·4	+15·0	−13·9	14 23	5 47	+16·5	−15·1	31·6
April . .	−13·4	+ 7·8	+13·5	− 4·7	+14·8	−15·0	14 4	5 31	+16·5	−15·8	32·3
May . .	−11·6	+ 5·2	+11·4	− 4·3	+12·8	−12·3	14 0	5 5	+14·6	−14·0	28·6
June . .	− 7·0	+ 3·7	+ 7·7	− 3·9	+ 9·7	− 7·4	14 7	4 50	+12·0	− 8·6	20·6
July . .	− 4·0	+ 2·2	+ 4·1	− 1·6	+ 5·1	− 4·3	14 13	5 6	+ 7·7	− 5·2	12·9
August . .	− 3·5	+ 2·3	+ 3·9	− 1·4	+ 4·8	− 4·0	14 3	5 30	+ 6·9	− 4·6	11·5
September .	− 4·3	+ 3·2	+ 4·9	− 2·2	+ 6·8	− 5·2	13 47	5 44	+ 8·1	− 5·5	13·6
October . .	− 8·2	+ 6·0	+ 9·8	− 4·4	+12·2	− 9·2	13 45	5 53	+12·7	− 9·7	22·4
November .	−10·0	+ 7·2	+12·8	− 4·9	+14·6	−10·3	14 3	6 2	+16·4	−12·1	28·5
December . .	− 9·8	+ 5·7	+12·6	− 4·6	+15·2	−10·5	13 52	6 12	+16·1	−11·3	27·4
Year .	− 8·7	+ 4·9	+10·0	− 3·6	+11·6	− 9·6	14 3	5 43	+13·2	−10·5	23·7

STATION: GORAKHPUR.

Latitude, 26° 46′ N.; Longitude, 83° 18′ E.; Elevation, 256 feet.
Data—
Hourly observations. 24 days each month (at Lucknow).
Six hourly ,, 6-7 years.
10 hours & 16 hours observations. 6 additional years.
Maxima and Minima. 12 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	− 9·4	+ 4·5	+12·4	− 3·0	+13·6	−12·2	14 40	6 39	+14·7	−12·2	26·9
February . .	−10·5	+ 4·7	+12·5	− 3·4	+13·0	−11·8	14 30	6 0	+15·1	−11·9	27·0
March . .	−11·2	+ 5·4	+12·5	− 3·5	+13·3	−13·3	14 30	5 47	+15·0	−13·9	28·9
April . .	−11·5	+ 4·4	+12·2	− 3·4	+12·8	−13·7	14 37	5 36	+14·7	−14·4	29·1
May . .	− 9·1	+ 3·0	+10·1	− 2·5	+10·5	−10·4	15 7	5 18	+13·1	−11·3	24·4
June . .	− 5·6	+ 1·0	+ 7·0	− 1·9	+ 7·3	− 7·2	14 45	5 38	+ 9·7	− 8·5	18·2
July . .	− 3·7	+ 1·7	+ 4·4	− 1·3	+ 5·2	− 4·4	14 0	5 41	+ 8·5	− 5·5	14·0
August . .	− 3·5	+ 1·6	+ 3·7	− 1·4	+ 5·0	− 6·4	13 30	5 45	+ 6·6	− 5·7	12·3
September .	− 3·6	+ 2·0	+ 4·8	− 1·6	+ 5·6	− 5·4	14 0	5 47	+ 7·5	− 6·2	13·7
October . .	− 6·9	+ 4·5	+ 8·9	− 3·3	+10·0	−10·1	14 6	5 51	+11·1	− 9·4	20·5
November .	− 9·0	+ 5·7	+12·4	− 4·7	+14·2	−11·3	14 20	6 0	+14·7	−11·8	26·5
December . .	− 7·4	+ 4·4	+12·0	− 4·2	+13·6	−11·7	14 24	6 37	+14·6	−11·7	26·3
Year .	− 7·6	+ 3·6	+ 9·4	− 2·8	+10·3	− 9·8	14 27	5 53	+12·1	−10·2	22·3

TABLE I.—*Diurnal variation of Temperature*—contd.

STATION: PATNA.

Latitude, 25° 37′ N.; Longitude, 85° 8′ E.; Elevation, 179 feet.
Data— Hourly observations. 27-28 days each month.
Six hourly „ 4-5 years.
Maxima and Minima 5 „

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	− 9·6	+5·5	+11·2	−4·2	+12·0	−10·1	14 30	5 30	+12·4	−11·2	23·6
February	−10·6	+6·1	+11·7	−4·8	+12·6	−11·7	14 22	5 20	+13·6	−12·7	26·3
March	−12·3	+7·1	+13·1	−5·2	+13·9	−12·9	14 22	5 15	+14·2	−14·6	28·8
April	−11·7	+5·9	+12·2	−4·4	+12·9	−12·4	14 48	5 8	+14·4	−14·5	28·9
May	−10·2	+5·1	+10·7	−4·0	+11·2	−10·5	14 57	4 38	+13·3	−10·5	23·8
June	− 6·8	+3·4	+ 7·4	−2·9	+ 7·8	− 7·0	14 56	4 43	+11·0	− 7·6	18·6
July	− 3·7	+2·4	+ 3·6	−1·7	+ 4·3	− 3·8	13 15	4 30	+ 7·3	− 4·8	12·1
August	− 3·6	+2·3	+ 3·6	−1·6	+ 3·9	− 3·9	14 45	4 48	+ 6·5	− 4·2	10·7
September	− 3·7	+2·4	+ 3·7	−1·7	+ 4·7	− 3·9	13 45	4 54	+ 6·8	− 4·8	11·6
October	− 5·9	+5·0	+ 6·1	−3·3	+ 7·4	− 6·8	13 58	5 30	+ 8·5	− 7·8	16·3
November	− 9·0	+7·3	+9·5	−4·7	+11·5	−10·3	13 42	5 37	+12·3	−11·7	24·0
December	−10·0	+6·4	+10·2	−4·8	+12·1	−10·4	14 0	5 0(?)	+12·4	−12·2	24·6
Year	− 8·1	+4·9	+ 8·6	−3·6	+ 9·5	− 8·6	14 17	5 3	+11·1	− 9·7	20·8

STATION: HAZARIBAGH.

Latitude, 24° 0′ N.; Longitude, 85° 24′ E.; Elevation, 2,010 feet.
Data— Hourly observations, 33-36 days each month.
Maxima and Minima, 6 years.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January	− 8·0	+1·5	+10·3	−4·0	+11·2	− 9·0	14 37	6 18	+11·8	−11·2	23·0
February	− 8·5	+1·6	+10·7	−3·7	+11·4	− 9·7	14 25	5 52	+12·4	−10·9	23·3
March	−10·0	+3·0	+ 9·8	−4·0	+11·4	−11·0	14 30	5 38	+12·7	−13·0	25·7
April	− 9·5	+2·5	+ 9·8	−3·6	+10·8	−11·0	14 10	5 35	+12·5	−12·6	25·1
May	− 9·3	+2·0	+ 8·5	−3·7	+10·0	− 9·7	14 13	4 51	+11·7	−11·7	23·4
June	− 5·2	+1·3	+ 4·9	−2·5	+ 6·8	− 5·5	13 38	4 56	+ 8·9	− 8·1	16·9
July	− 2·9	+0·6	+ 3·0	−1·5	+ 4·1	− 3·2	13 54	5 15	+ 6·1	− 5·2	11·3
August	− 3·0	+1·0	+ 2·6	−1·4	+ 3·6	− 3·3	13 30	5 34	+ 5·5	− 5·3	10·8
September	− 4·3	+1·3	+ 4·3	−2·1	+ 6·0	− 4·5	13 18	5 10	+ 6·5	− 5·8	12·3
October	− 5·8	+2·9	+ 6·3	−3·2	+ 7·5	− 6·6	14 15	5 36	+ 8·3	− 8·0	16·3
November	− 7·0	+3·3	+ 8·2	−4·0	+ 9·4	− 7·8	14 20	5 34	+10·3	−10·4	20·7
December	− 7·8	+2·0	+ 9·5	−3·9	+10·9	− 8·7	14 34	5 54	+11·4	−11·2	22·6
Year	− 6·8	+1·9	+ 7·3	−3·1	+ 8·6	− 7·5	14 7	5 31	+ 9·8	− 9·5	19·3

Table I.—Diurnal variation of Temperature—contd.

STATION: JUBBULPORE.

Latitude 23° 9′ N.; Longitude, 79° 59′ E.; Elevation, 1,351 feet.
Data— Hourly observations, 24 days each month.
Maxima and Minima, 5 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−11·3	+3·4	+14·4	−3·1	+14·9	−13·0	14 47	6 17	+16·2	−14·0	30·2
February . .	−11·4	+3·4	+13·1	−2·4	+13·9	−13·1	14 56	6 4	+15·5	−13·9	29·4
March . .	−13 0	+4·4	+13·9	−2·9	+14·3	−14·3	14 52	5 43	+15·8	−15·7	31·5
April . .	−12·7	+5·2	+12·2	−3 1	+13·1	−14·2	14 30	5 32	+14·6	−15·4	30·0
May . .	−11·6	+5·1	+10·7	−3·0	+11·6	−11·8	14 7	4 50	+14·0	−12·1	26·1
June . .	− 6·3	+3·0	+ 6·5	−3·0	+ 8·7	− 6·4	14 0	5 0	+11·1	− 8·5	19·6
July . .	− 3·5	+1 2	+ 3·9	−1·4	+ 5·4	− 3·9	14 17	5 35	+ 7·0	− 4·7	11·7
August . .	− 3·5	+1·3	+ 3·8	−1·6	+ 4·6	− 3·7	14 30	5 36	+ 6·6	− 4·0	10·6
September . .	− 5·0	+2·7	+ 5·3	−2 2	+ 6·6	− 5·5	14 5	5 39	+ 7·5	− 5·0	12·5
October . .	− 9·3	+5·3	+ 9·9	−3·3	+11·7	−10·5	14 37	5 41	+12·4	−10·0	22·4
November .	−12·1	+6·5	+13·6	−3·6	+14·5	−13·5	14 30	5 42	+15·9	−14·7	30·6
December . .	−11·7	+4·8	+14·2	−3·6	+15·4	−13·5	14 24	6 3	+16·3	−14·0	30·3
Year . .	− 9·3	+3·9	+10·1	−2·8	+11·2	−10·3	14 28	5 39	+12·7	−11·0	23·7

STATION: NAGPUR.

Latitude, 21° 9′ N.; Longitude, 79° 11′ E.; Elevation, 1,025 feet.
Data— Hourly observations, 24—28 days each month.
Maxima and Minima, 6 years.

MONTH.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−10·8	+3·6	+13·9	−4·1	+14·4	−12·8	15 10	6 37	+15·4	−13·3	28·7
February . .	−10·8	+4·2	+13·7	−3·1	+14·0	−13·3	15 17	6 13	+15·4	−13·9	29·3
March . .	−11·7	+5·2	+13·7	−4·2	+13·8	−13·2	15 0	5 43	+15·7	−16·5	32·2
April . .	−12·1	+5 4	+11·7	−4·4	+13·0	−13·9	14 39	5 31	+14·7	−14 9	29·6
May . .	−10·6	+5·3	+10·6	−4·7	+12·7	−12·0	14 30	5 33	+14·5	−13·1	27·6
June . .	− 7·0	+2·6	+ 7·6	−2 4	+ 8·8	− 7·6	14 39	4 58	+13·2	− 8·6	21·8
July . .	− 4·0	+2·2	+ 4·0	−1·6	+ 4·4	− 4·4	14 0	5 33	+ 8·1	− 6·0	14·1
August . .	− 4·3	+2·7	+ 4·0	−1·9	+ 5·4	− 4·8	13 0	5 30	+ 7·3	− 6·2	13·5
September . .	− 5 5	+3·4	+ 6·0	−2·7	+ 7·2	− 6·1	13 15	5 13	+8·4	− 7·1	15·5
October . .	− 9·2	+6·1	+ 9·3	−4·0	+10·8	−10·4	13 30	5 35	+10·1	−11·3	21·4
November . .	− 9·5	+5·4	+11·1	−4·2	+11·8	−11·6	14 30	5 45	+12·8	−13·7	26·5
December . .	−10·8	+4·8	+13·1	−4·3	+13·8	−12·2	14 43	5 53	+14·8	−12·8	27·6
Year . .	− 8·9	+4·2	+ 9·9	−3·5	+10·8	−10·2	14 21	5 40	+12·5	−11·4	24·0

TABLE I.—*Diurnal variation of Temperature*—concld.

STATION: PACHMARHI.

Latitude, 22° 28 N.; Longitude, 78° 28′ E.; Elevation 3,504 feet.
Data— Hourly observations, 24—28 days each month.
Maxima and Minima, 6 years.

Month.	4 hours.	10 hours.	16 hours.	22 hours.	Periodic Maximum.	Periodic Minimum.	Time of Maximum.	Time of Minimum.	Self-registered Maximum.	Self-registered Minimum.	Mean daily Range.
	°	°	°	°	°	°	H. M.	H. M.	°	°	°
January . .	−9·5	+8·1	+11·8	−6·1	+12·7	− 9·9	14 20	5 43	+14·4	− 9·8	24·3
February . .	−9·3	+5·7	+10·4	−4·5	+11·1	−10·1	14 43	5 2	+12·3	−11·0	23·3
March . .	−8·2	+5 2	+ 8·9	−4 6	+ 9·7	− 8·7	14 30	5 30	+10·5	−13·5	24·0
April . .	−7·7	+3·9	+ 8·4	−3·1	+ 8·5	− 9·1	15 30	5 35	+10·1	−12·3	22·4
May . .	−6·9	+2·4	+ 7·6	−2·4	+ 8·1	− 7·7	14 15	5 32	+10·0	− 9·0	19·0
June . .	−4·3	+0·1	+ 5·5	−0·0	+ 5·6	− 5·2	15 30	5 42	+ 8·1	− 3·4	14·5
July . .	−2·1	+0·3	+ 2·6	−0·2	+ 2·9	− 2·5	14 7	5 30	+ 3·9	− 4·3	8·2
August . .	−2·4	+0·3	+ 2·9	−0·3	+ 3·3	− 2·9	15 0	5 47	+ 4·9	− 2·5	7·4
September .	−3·6	+2·1	+ 3·8	−1·6	+ 5·2	− 4·2	13 30	5 37	+ 6·1	− 4·0	10·1
October . .	−7·9	+6·5	+ 7·4	−3·4	+ 8·0	− 8·7	13 55	5 33	+°9·1	− 8·2	17·3
November . .	−8·9	+8·2	+10·1	−5·5	+11·0	−10·2	13 55	5 38	+10·2	−11·7	21·9
December .	−9·1	+8·8	+10·1	−6·0	+11·8	− 9·8	13 20	5 35	+12·8	−11·6	24·4
Year .	−6·7	+4·3	+ 7·5	−3·1	+ 8·2	− 7·4	14 23	5 34	+ 9·4	− 8·7	18·1

At most stations, especially where the hourly means for a few days in each month have been corrected by the insertion of the six-hourly means for several years, the epochs of maximum and minimum, and the variations from the means at these epochs and at the hours given in the table, exhibit a fairly regular annual inequality. The most important exception to this rule is Patna, where the hour of minimum is apparently very irregular; probably owing to some defect in the observations. The epoch of minimum varies with the hour of sunrise, generally preceding it by a quarter to half an hour; and, on the whole, occurring earlier, as the elevation of the station is greater. The coincidence of the periodic minimum with sunrise, at stations on the plains, would be closer, if it were assumed, as was done in discussing the temperature of Allahabad, (Vol. I, page 317), that there is a sudden break in the curve at the minimum, and that the parts of the curve, for an hour or two before and after this break, may be regarded as straight lines. At every station on the plains, except Kurrachee, the maximum occurs between 2 and 3 P.M. on the mean of the year; the earlier hour of its occurrence at Kurrachee being clearly due to the sea breeze. On most parts of the plain, with the apparent exception of Roorkee, the maximum occurs later in the months when west-winds blow, than when the wind is easterly or the air calm. At the hill stations, the maximum is reached sooner in the afternoon than in the plains; especially at places like Chakrata, situated on a narrow ridge, in the inner zone of the mountains, and fully exposed to the diurnal mountain winds. At Leh, in the Upper Indus Valley, the maximum occurs before 2 P.M. in winter; but, in June, it is not reached until 3 hours 26 minutes P.M.; being almost as much

retarded as at any place on the plains. The high latitude of Leh doubtless tends in summer, when the days are lengthened in consequence, to render the maximum considerably later than it would be at a place, of the same elevation, further south.

The range, indicated by self-recording thermometers is, in every case, considerably in excess of the periodic range; particularly in the rainy season, when the maximum temperature is subject to sudden and irregular changes, owing to the sun breaking through the clouds, for short periods, at uncertain hours of the day. The periodic and aperiodic minima do not differ so much as the maxima; and, at several of the stations, the two are identical in the clear still nights of the cold weather. The ratios of the aperiodic to the periodic ranges, on the mean of all the stations in Table I, except the first three, are the following:—

January.	February.	March.	Aprl.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1·09	1·09	1·13	1·13	1·17	1·26	1·42	1·26	1·17	1·07	1·10	1·11	1·14

Diurnal Range (Aperiodic).

The stations in Table I being few in number, while equally good observations of the daily range have been made at all the Government observatories and some others, the whole of the comparable values of this important climatological factor are given in Table II. The number of years, on which the means are founded, is not mentioned in this table; but the figures are, for the most part, taken from the reports of the year 1375—80, only those years being included, in which the thermometers were exposed under thatched sheds. The ranges at Agra, Delhi and Bickaneer are less than they ought to be, owing to the situation of the observatories in the interior of large towns; and there is probably some error in the same direction at Lahore.

Table II.—*Mean Diurnal Range of Temperature.*

Stations.	January.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
Yarkand	22·6	...	...	29·8	30·0	30·2	28·1	...	...	25·0	25·9	24·3	...
Gilgit	19·8	19·3	21·2	20·4	23·8	28·6	25·4	24·4	25·2	28·4	...	23·0	...
Leh	23·5	23·6	21·9	25·7	26·7	27·2	27·4	25·4	27·1	26·1	24·8	22·7	25·2
Murree	12·6	12·9	15·0	15·7	16·5	17·2	15·9	14·6	15·4	16·5	15·4	12·6	15·0
Simla	18·7	19·3	19·8	21·9	21·9	20·4	14·7	14·8	16·8	19·3	19·4	18·5	18·8
Chakráta	15·3	15·1	17·1	17·9	17·4	15·1	10·4	9·4	11·0	14·6	15·3	15·7	14·5
Mussooree . . .	14·0	13·2	14·0	16·0	16·3	15·2	9·4	8·2	10·3	12·8	16·3	12·3	13·1
Dehra	22·6	22·1	23·8	25·1	23·3	19·7	12·2	11·9	14·5	21·0	23·8	22·7	20·2
Pauri	15·3	15·2	19·5	20·7	20·8	12·7	11·9	9·3	11·3	18·4	18·2	17·3	15·9

TABLE II.—*Mean Diurnal Range of Temperature*—contd.

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
Ranikhet . . .	15·2	15·3	17·3	17·4	17·1	13·8	10·7	9·3	12·3	14·9	16·3	15·6	14·6
Naini Tal . . .	15·8	16·7	16·7	17·9	15·9	11·4	9·3	10·0	10·2	16·9	18·5	18·3	14·8
Pithoragarh . . .	19·9	18·8	20·5	20·5	19·7	15·2	15·4	12·9	14·1	20·4	20·7	22·8	18·4
Katmandu . . .	30·5	29·2	26·6	31·2	23·3	19·6	18·8	18·9	19·6	24·4	32·5	34·5	25·8?
Quetta	27·8	21·4	25·1	29·6	30·0	29·4	27·2	26·8	33·9	35·8	36·5	29·4	29·4
Jacobabad . . .	33·6	28·7	31·6	32·3	32·1	27·5	24·2	22·2	25·5	32·9	33·8	31·8	29·7
Hyderabad . . .	28·8	25·2	30·0	30·5	28·8	22·3	19·5	15·6	20·8	26·1	27·7	26·4	25·1
Kurrachee . . .	24·3	24·5	22·3	19·2	16·0	13·4	11·2	10·4	13·0	21·6	27·4	26·2	19·1
Bhuj	25·6	25·4	29·0	28·7	24·4	17·7	13·5	13·4	15·8	22·7	25·0	25·3	22·2
Rajkot	34·1	33·2	35·5	33·3	29·4	20·9	15·8	15·0	17·1	26·8	31·7	32·2	27·1
Deesa	30·8	31·2	31·1	30·7	27·0	20·8	14·3	11·8	16·4	28·1	33·1	32·2	25·6
Súrat	31·0	31·2	32·4	28·2	20·3	14·8	11·4	11·0	12·9	21·1	27·3	28·5	22·5
Malegaon . . .	35·1	35·3	36·1	32·7	28·1	21·4	14·7	12·0	16·2	26·4	29·5	31·7	26·6
Khandwa . . .	32·2	33·7	33·2	30·9	26·5	21·3	14·0	13·2	15·0	25·2	31·2	32·2	25·7
Chikalda . . .	16·6	18·9	19·1	20·5	20·4	16·9	9·1	8·1	9·5	12·9	15·0	16·1	15·3
Buldana	20·5	21·2	21·4	21·8	21·4	18·2	13·3	12·8	12·4	15·2	19·0	19·9	18·1
Akola	31·8	32·5	33·4	32·0	26·2	22·1	15·8	15·1	16·5	24·8	30·2	30·2	25·9
Amráoti	28·2	29·4	30·9	31·4	28·4	21·8	15·3	14·8	16·4	23·0	26·7	27·0	24·4
Pachmarhi . . .	24·3	23·3	24·0	22·4	19·0	14·5	8·2	7·4	10·1	17·3	21·9	24·4	18·1
Hoshangabad . . .	28·8	29·0	32·4	30·9	27·0	20·2	11·6	11·8	14·5	21·6	27·2	27·0	23·5
Jubbulpore . . .	30·2	29·4	31·5	30·0	26·1	19·6	11·7	10·6	12·5	22·4	30·6	30·3	23·7
Seoni	29·7	29·1	30·9	31·1	27·0	20·8	13·3	12·?	14·6	21·2	26·8	27·5	23·7
Nágpur	28·7	29·3	32·2	29·6	27·6	21·8	14·1	13·5	15·5	21·4	26·5	27·6	24·0
Chánda	31·3	31·1	31·8	27·9	25·3	17·8	13·4	13·0	14·6	20·4	27·2	29·8	23·6
Raipur	26·4	25·0	29·2	26·8	24·9	19·6	12·6	11·5	13·2	17·3	22·4	24·7	21·1
Sambalpur . . .	27·5	26·2	31·5	28·9	25·7	17·6	11·0	11·3	13·4	16·9	22·7	25·4	21·5
Neemuch . . .	30·2	27·8	29·7	23·4	25·9	21·1	13·9	12·2	16·1	24·4	28·8	27·8	23·4
Indore	26·8	29·0	32·4	31·6	25·8	19·8	12·0	10·0	11·5	20·6	23·6	26·4	22·5
Jhansi	26·0	26·6	28·3	28·2	26·4	21·0	13·8	13·2	15·4	24·8	28·8	26·5	23·3
Saugor	22·9	24·0	28·2	29·4	26·3	22·8	12·5	12·4	15·3	21·4	23·8	24·1	21·9
Nowgong . . .	30·7	29·6	33·3	32·5	26·8	19·4	12·3	11·8	15·2	26·6	31·8	30·0	25·0
Sutna	27·2	26·3	30·7	29·0	24·9	19·1	13·5	10·4	12·5	21·3	27·3	28·5	22·6
Hazaribagh . . .	23·0	23·3	25·7	25·1	23·4	16·9	11·3	10·8	12·3	16·3	20·7	22·6	19·3
Gya	24·2	21·9	29·7	29·6	26·8	23·1	13·3	12·4	13·2	17·2	23·7	25·0	21·9
Patna	23·6	26·3	28·8	28·9	23·9	18·6	12·1	10·7	11·6	16·3	24·0	24·6	20·8

Mean Diurnal Range of Temperature—contd.

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Gorakhpur . . .	26·9	27·0	28·9	29·1	24·4	18·2	14·0	12·3	13·7	20·5	26·5	26·3	22·3
Benares	28·1	29·2	31·0	31·0	25·8	20·0	13·0	11·9	14 3	22·0	28·3	28·4	23·6
Allahabad . . .	26·3	28·8	31·6	32·3	28·6	20·6	12·9	11·5	13·6	22·4	28·5	27·4	23·7
Lucknow . . .	28·9	29·1	31·7	32·4	27·6	21·7	14·4	13 5	15 8	26·4	33·0	31·4	25·5
Bareilly . . .	25·7	24·8	27·9	29·6	27·7	21·6	15·7	13·2	15·4	22·9	29·4	26 9	23·4
Fatehgarh . . .	26·7	27·8	28·8	31·4	28·4	21·2	13·7	12·0	14·6	27·2	31·8	28·4	24·3
Agra	23·7	25·0	27·2	27·6	25·1	19·0	11·3	11·7	13·4	22·4	26 5	24·1	21·4
Delhi	23·6	22·2	25·8	26·9	24·9	20·9	14·6	14·7	16·7	22·4	26 4	24·2	21·8
Meerut	28·0	26·6	29·2	30·0	27·3	22·6	14 5	14·0	17·4	26·6	31·9	28·9	24·7
Roorkee	26·9	25·6	29·0	31·1	28 7	22·5	14·6	13·7	18·5	28·1	32·8	29·2	25·0
Jeypur	29·3	30·6	26·9	29 2	29·5	21·8	13·8	12·6	18·5	28·8	35 0	29·6	25·5
Sambhar . . .	31·8	30·6	23·9	25·0	25·8	18·9	13·8	13·8	18·0	26·0	31·5	29·8	24·1
Ajmere	32·4	31·2	32·8	31·4	28·6	22·6	16·6	14·9	19·8	30·4	34·8	33·4	27·4
Mount Abu . . .	18·4	16·6	17·6	17·7	17·8	16·2	10·3	9·2	10·7	14·9	17·1	17·5	15·3
Pachbudra . . .	38·0	33·8	41·3	37·0	30·6	24·1	18·5	18·5	24·3	32·2	38·7	36·4	31·1
Bickaneer . . .	27·5	24·6	25·5	24·7	24·3	20·6	16·6	14·8	18·0	23·1	26·4	25·4	22 6
Sirsa	29·8	27·4	31·7	31·0	29·0	23·3	19·1	18·6	23·4	32·5	34·4	30·1	27·5
Ludhiana . . .	27·7	24·5	27·4	30·1	28·7	25·7	16·6	15·8	19·3	25·8	28·6	27·3	24·8
Lahore	27·4	24·5	26·9	30·3	29·0	27·2	19·5	17·9	20·5	28·2	30·4	27·9	25·8
Mooltan	29·3	27·6	29·3	31·3	29·2	25·6	21·9	19·6	23·6	28·1	28·3	29·0	26·9
Dera Ismail Khan . .	29·5	25·6	27·9	27·7	27·0	26·1	21·1	20·1	24·7	30·0	31·8	30·3	26·8
Sialkot	26·8	24·9	28·6	30·4	27·6	25·6	17·5	16·2	21·5	27·1	33 0	28·5	25·4
Rawal Pindi . . .	26·2	23·4	26·8	28·6	28·8	29·9	22·4	20·5	27·8	31·8	33·0	29·6	27·4
Peshawar . . .	27·4	24·2	26·4	26·5	28·7	29·2	24·8	21·6	26·5	29·7	30·9	28·4	27·0
Thull	30·1	23·0	31·8	38·7	25·9	24·2	20·8	22·4	25·1	32·4	30·3	...	...

In the Himalaya, with the apparent exception of Katmandu, where there is probably some unascertained peculiarity in the exposure of the thermometers, the daily range of temperature diminishes from the plains, up to an elevation of 5,000 or 6,000 feet; above which it appears to increase again. This increase is, however, probably owing to the highest station, Leh, being situated in the arid region, behind the snowy ranges of the Himalaya proper; for Gilghit, in a similar situation, and at an elevation between 5,000 and 6,000 feet, has a range nearly or quite as great as Leh. In Central India and Rajputana also, the ranges at hill stations, such as Chikalda, Pachmarhi, and Mount Abu, are much less than at adjacent stations of lower elevation, like Akola, Hoshangabad and Deesa. In Afghanistan and Beluchistan, however, and probably on table-lands generally, this rule does not hold; the range at Quetta being equal to that of Jacobabad. The

diminished range at hill stations, compared with places on the plains, is due to causes well understood—the downward movement of the air, cooled by radiation, from the hill slopes at night, and the upward currents, dynamically cooled, that blow during the day, together with the generally larger proportion of cloudy sky at the hill stations. On a plateau almost surrounded by hills, or at the bottom of a deep valley between mountain ranges, as at Quetta and Leh, these causes do not act in the same way as on isolated peaks and ridges. Possibly, the large range observed at Katmandu, may also be due to the position of the place in the centre of the valley of Nepal.

On the plains, the daily range is greatest at Jacobabad in Upper Sind, and gradually diminishes towards the east, south-east and north-east; being, on the whole, inversely proportional to the rainfall, or rather to the humidity of the air and the amount of cloud: for, on the sea-coast of Sind and Cutch, the range of temperature is small, although the rainfall is inconsiderable.

In the arid regions of the Trans-Himalaya, the diurnal range is least in winter; and over the greater part of North-Western India, the maximum occurs in the hot weather months, March and April; but at many places in Rajputana and the Punjab, the range in November exceeds that of April. Wherever the winter rains occur with any regularity, two maxima, separated by a secondary minimum in January or February, are observed: but in the Central Provinces and Berar, there is only one maximum. The minimum range of the year, at every station in India, occurs in the middle of the rainy season.

The average range, for any month, does not exceed 34°: and the actual range of a single day, even in Sind, probably never amounts to more than 50°F. The greater ranges, sometimes recorded in Australia and other countries, probably do not represent real variations in the temperature of the air, but are due to the effects of radiation on the thermometers.

In Australia, I understand, there is often a good deal of rivalry between amateur observers, as to which of them can induce the thermometer "in the shade" to mount highest in summer; the shade being sometimes that given by a screen of tin-plate or corrugated iron, little larger than the thermometer it covers.

Calculation of Daily Means.

From Table I, it appears that, at most places, the sunrise temperature or periodic minimum is, on the average of the year, just about as much below the mean of the 24 hours, as the temperature at 4 P.M. is above it; and the differences, in any single month, are usually not great. The arithmetical mean of observations, made at sunrise and 4 P.M., should therefore give a close approximation to the true mean of the day. This combination of hours was adopted by Messrs. VonSchlagintweit, in the meteorological volume of their *Results of a Scientific Mission to India and High Asia.*

The combination of the 4 P.M. temperature with the self-registered minimum, adopted, for many stations, in the annual reports on the meteorology of India, gives results which are too low; the difference being in many cases more than a degree. The mean of the maximum and minimum thermometer readings is usually much too high, especially in the rainy season; but during the long days of May and June, when hot winds blow and the temperature does not vary much between noon and 4 P.M., this combination sometimes gives a result which is less than the true mean of the day.

Of all the combinations that have been adopted in the annual meteorological reports, the best is that of the observations at 4, 10, 16 and 22 hours, though it almost invariably gives a result a little too high. The mean of the minimum, 10 h. and 16 h. observations, is also, with very few exceptions, always too high; but, like the mean of four equidistant observations, it forms a good datum from which to deduce the true mean, by the addition of a negative correction. The method of variable corrections, proportional to the range, (as shown by self-registering instruments) has been described by Mr. Blanford in the *Indian Meteorologist's Vade Mecum*. If this method be adopted, the factors, by which the range is to be multiplied, to get the corrections applicable to the crude mean of each combination of hours, adopted in the annual reports, are those in Table III.

TABLE III-A.—*Range Factors for reducing the means of the Maximum and Minimum observations to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Leh	—·07	+·02	·00	·00	—·03	—·03	—·0	—·04	—·02	·00	—·01	—·03
Chakráta	—·15	—·14	—·07	—·06	—·03	—·03	—·07	—·08	—·12	—·10	—·11	—·14
Ranikhet	—·09	—·04	—·03	+·02	—·01	—·02	—·06	—·09	—·09	—·07	—·05	—·05
Lahore	—·06	—·04	—·03	—·01	—·01	—·04	—·06	—·06	—·03	—·05	—·07	—·07
Roorkee	—·04	—·05	—·02	·00	—·01	—·02	—·06	—·08	—·05	—·04	—·05	—·07
Agra	—·04	—·03	—·04	·00	—·01	—·03	+·02	·00	—·01	—·02	—·03	—·02
Lucknow	—·01	·00	+·01	+·02	·00	—·02	—·06	—·06	—·06	—·03	—·02	—·04
Gorakhpur	—·06	—·06	—·02	—·01	—·04	—·03	—·11	—·04	—·05	—·04	—·05	—·05
Allahabad	—·06	—·05	—·02	—·01	—·01	—·06	—·06	—·10	—·10	—·07	—·08	—·09
Patna	—·03	—·02	+·01	·00	—·06	—·09	—·10	—·11	—·09	—·02	—·01	·00
Hazaribagh	—·01	—·03	+·01	·00	·00	—·02	—·04	—·01	—·03	—·01	·00	·00
Kurrachee	—·03	—·06	—·04	—·11	—·18	—·17	—·13	—·20.	—·12	—·13	—·10	—·04
Deesa	+·01	+·03	·00	+·04	+·02	—·03	—·02	—·04	—·07	—·03	+·01	+·03
Ajmere	—·05	—·01	—·01	+·02	—·03	—·07	—·10	—·06	—·07	—·04	—·05	—·05
Jeypur	—·06	—·02	—·02	·00	—·03	—·04	—·11	—·11	—·07	—·06	—·05	—·06
Jhansi	—·02	—·03	—·02	—·02	—·01	—·07	—·12	—·08	—·07	—·02	—·01	—·01
Jubbulpore	—·04	—·03	·00	+·01	—·04	—·07	—·11	—·12	—·10	—·05	—·02	—·04
Nagpur	—·04	—·03	+·01	·00	—·03	—·10	—·07	—·04	—·04	+·03	+·02	—·04
Pachmarhi	—·15	—·03	+·06	+·05	—·03	—·05	+·02	—·16	—·10	—·03	+·03	—·02

TABLE III—B.—*Range Factors for reducing the Means of the 16 hours observation and self-registered Minimum to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Leh	+·05	+·10	+·05	+·10	+·05	+·01	—·01	+·02	+·06	+·08	+·07	+·04
Chakrata	+·12	+·06	+·10	+·07	+·08	+·10	+·11	+·11	+·08	+·08	+·08	+·10
Ranikhet	+·05	+·06	+·08	+·11	+·10	+·08	+·07	+·03	+·03	+·02	+·07	+·09
Lahore	—·02	·00	+·01	+·03	+·03	+·02	+·03	+·04	+·01	—·01	—·02	—·02
Roorkee	+·01	·00	+·02	+·04	+·04	+·04	+·03	—·01	+·02	+·01	+·01	+·01
Agra	·00	+·01	·00	+·03	+·04	+·05	+·08	+·10	+·05	·00	·00	+·01
Lucknow	+·03	+·02	+·04	+·06	+·05	+·06	+·06	+·04	+·06	+·02	+·03	+·01
Gorakhpur	—·02	—·01	+·02	+·04	+·02	+·04	+·04	+·08	+·05	+·01	—·01	—·01
Allahabad	—·02	—·01	+·02	+·03	+·04	+·03	+·03	+·03	+·02	·00	—·01	—·02
Patna	·00	+·02	+·03	+·04	·00	·00	+·05	+·03	+·05	+·05	+·05	+·04
Hazaribagh	+·02	·00	+·06	+·06	+·09	+·09	+·10	+·13	+·06	+·05	+·05	+·04
Kurrachee	+·03	+·02	+·08	+·05	+·02	+·04	+·08	·00	+·05	—·04	·00	+·04
Deesa	+·04	+·04	+·04	+·08	+·05	+·04	+·06	+·05	—·01	+·01	+·06	+·06
Ajmere	—·01	+·03	+·04	+·06	+·03	·00	—·01	—·01	+·01	·00	·00	+·01
Jeypur	—·03	+·02	+·02	+·04	+·04	+·04	+·03	+·01	·00	—·01	—·01	—·04
Jhansi	+·03	+·02	+·03	+·03	+·05	+·06	+·02	+·07	+·01	+·04	+·04	+·03
Jubbulpore	—·01	+·01	+·03	+·05	+·03	+·05	+·03	+·01	—·01	·00	+·02	·00
Nagpur	—·01	·00	+·04	+·05	+·04	+·02	+·07	+·08	+·04	+·05	+·05	·00
Pachmarhi	—·04	+·01	+·10	+·06	+·04	+·03	+·10	—·03	+·01	+·02	+·04	+·03

TABLE III—C.—*Range Factors for reducing the Means of the 10 hours, 16 hours, and Minimum observations to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Leh	—·06	—·03	—·03	·00	—·03	—·04	—·02	—·04	—·03	·00	—·02	—·05
Chakráta	—·03	—·03	—·02	—·05	—·04	—·02	·00	—·01	—·04	—·06	—·06	—·03
Ranikhet	—·02	·00	·00	+·01	·00	—·01	—·00	—·03	—·04	—·05	—·02	+·01
Lahore	—·05	—·04	—·04	—·04	—·04	—·03	—·01	—·02	—·05	—·07	—·08	—·07
Roorkee	—·02	—·04	—·04	—·05	—·04	—·01	—·01	—·06	—·04	—·07	—·07	—·05
Agra	—·02	—·01	—·04	—·02	—·01	·00	+·03	+·04	·00	—·04	—·04	—·02
Lucknow	—·02	—·03	—·03	—·03	—·02	·00	—·02	—·01	—·03	—·06	—·06	—·05
Gorakhpur	—·07	—·07	—·05	—·02	—·02	+·01	—·01	—·01	—·01	—·06	—·08	—·06
Allahabad	—·06	—·06	—·06	—·06	—·03	—·02	—·02	—·04	—·07	—·09	—·09	—·08

TABLE III—C.—*Range Factors for reducing the Means of the 10 hours, 16 hours, and Minimum observations to true diurnal Means*—contd.

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Patna	—·08	—·07	—·06	—·04	—·07	—·06	—·03	—·05	—·04	—·07	—·07	—·06
Hazaribagh	—·01	·00	·00	·00	+·02	+·04	+·05	+·05	·00	—·02	—·02	·00
Kurrachee	—·03	—·05	—·02	—·04	—·06	—·06	—·01	—·06	—·05	—·11	—·08	—·03
Deesa	—·02	—·02	—·02	+·02	+·03	+·03	+·04	+·02	—·04	—·08	—·04	—·02
Ajmere	—·08	—·04	—·05	—·04	—·04	—·04	—·05	—·05	—·07	—·11	—·11	—·07
Jeypur	—·10	—·07	—·04	—·02	—·04	·00	—·02	—·03	—·05	—·09	—·13	—·11
Jhansi	—·02	—·03	—·03	—·04	—·01	·00	—·01	—·01	—·06	—·06	—·06	—·04
Jubbulpore	—·04	—·03	—·03	—·02	—·04	—·02	—·01	—·03	—·08	—·08	—·06	—·06
Nagpur	—·05	—·05	—·03	—·02	—·03	—·02	·00	—·01	—·05	—·06	—·04	—·06
Pachmarhi	—·14	—·07	—·01	·00	—·02	+·02	+·06	—·03	—·06	—·11	—·10	—·10

TABLE III—D.—*Range Factors for reducing the Means of observations at 4, 10, 16 and 22 hours to true diurnal Means.*

STATIONS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Leh	—·02	—·02	—·02	·00	·00	·00	·00	·00	·00	·00	—·02	—·03
Lahore	—·03	—·02	—·02	—·01	·00	—·01	·00	—·01	—·02	—·03	—·04	—·03
Roorkee	—·02	—·02	—·02	—·02	—·01	·00	·00	—·03	—·01	—·03	—·03	—·02
Agra	—·05	—·03	—·04	—·03	—·02	—·01	—·01	·00	—·02	—·03	—·04	—·04
Lucknow	—·04	—·03	—·02	—·01	—·01	+·01	—·02	—·01	—·02	—·03	—·03	—·04
Gorakhpur	—·04	—·03	—·03	—·02	—·02	—·01	—·02	—·01	—·03	—·04	—·04	—·05
Allahabad	—·03	—·03	—·03	—·03	—·01	·00	—·01	—·03	—·03	—·04	—·05	—·04
Patna	—·03	—·02	—·02	—·02	—·02	—·01	—·01	—·02	—·02	—·03	—·03	—·02
Hazaribagh	·00	·00	+·01	+·01	+·03	+·02	+·02	·00	+·02	·00	·00	·00
Kurrachee	—·03	—·02	—·03	—·01	—·01	—·02	—·01	—·02	—·02	—·03	—·04	—·04
Deesa	—·02	—·03	—·02	—·01	—·01	·00	—·02	—·01	—·02	—·02	—·03	—·04
Ajmere	—·04	—·02	—·02	—·02	—·03	—·01	—·01	·00	—·02	—·03	—·03	—·03
Jeypur	—·06	—·03	—·03	—·01	—·01	+·01	—·01	—·01	—·01	—·03	—·07	—·06
Jhansi	—·04	—·03	—·03	—·02	—·01	—·01	—·02	—·01	—·02	—·03	—·06	—·04
Jubbulpore	—·03	—·02	—·02	—·01	—·01	·00	·00	·00	—·02	—·03	—·03	—·03
Nagpur	—·02	—·03	—·02	—·01	·00	—·01	—·01	—·01	—·02	—·02	—·03	—·03
Pachmarhi	—·04	—·02	—·01	—·02	—·01	—·02	—·02	—·01	—·02	—·04	—·05	—·04

Monthly and Annual Mean Temperatures.

In the next table, the most probable values of the monthly mean temperatures, at all the regular meteorological observatories, in the region with which this paper deals, and at many minor stations, are given. The names of the observatories are distinguished by being printed in small capitals. The original registers of all the observatories in the North-Western Provinces and Eastern Rajputana have been gone over and corrected, and the resulting means reduced by means of factors from Table III, or combinations of them. Thus, for Bareilly, the means of the factors for Rurki and Lucknow have been used, and for Benares those of Allahabad. The monthly means for the minor stations have been corrected, as far as possible, in a similar manner.

In the Punjab, prior to 1876, the thermometers, at the observatories, were generally exposed on Glaisher's stands, and the means of the maximum and minimum thermometer readings were taken to represent the daily means. Under these circumstances, the figures published in the annual reports on the meteorology of the Punjab, had no very direct relation to the true mean temperatures; and though they were empirically corrected, before the means in Table IV were struck, the latter must be looked upon as somewhat doubtful in consequence. Another circumstance which renders the mean temperatures of Punjab stations in Table IV a little uncertain is, that hourly observations have been made at only one station in that Province, and the range factors of Lahore probably do not fit Peshawar or Rawal Pindi. These uncertainties, however, probably do not affect the annual mean, to the extent of more than half a degree.

For the hill observatories in the Punjab and Beluchistan, the range factors of Chakráta or Ranikhet have been employed, and for the hill stations in Rajputana and the Central Provinces, those of Pachmarhi. For stations in the Central Provinces and Central India, between 1,000 and 2,000 feet elevation, the factors of Jubbulpore have been used; and for lower stations in these provinces and Berar, the factors of Nagpur. In the Bombay Presidency, the factors of Bombay, Deesa and Kurrachee, or combinations of them, have been employed; except for Jacobabad, for which station the Jeypore factors have been used.

Table IV.—*Monthly Mean Temperatures at places in North-Western India.*

Region.	Place.	Elevation above sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		Feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	
Himalaya and W. Tibet	Yarkand	4,200	20·5	30·9	44·4	64·1	69·4	75·8	81·7	(77·9)	(61·1)*	44·1*	35·0	24·2	52·4	1—2
	Gilgit	4,800	39·4	44·9	56·0	63·1	71·9	81·4	81·4	79·3	70·4	60·3	48·1	40·0	61·4	1—3
	Skardo	7,700	32·0	39·0	45·0	51·0	58·0	66·0	69·0	68·0	59·0	52·5	43·0	33·0	51·3	1
	Leh	11,538	17·0	22·9	32·3	43·5	48·9	56·4	60·6	60·3	53·9	42·3	32·3	24·1	41·3	6—11
	Spiti	13,000	19·7	20·4	23·9	39·6	47·9	58·3	61·9	57·3	54·7	41·1	24·9	18·3	39·0	1
	Kanam	9,300	28·8	34·6	37·2	46·6	56·7	63·7	66·6	65·0	61·3	54·1	42·6	36·1	49·4	2
	Kardong	10,240	24·0	36·0	44·0	47·0	49·0	54·0	63·0	60·0	52·0	46·0	37·0	27·0	44·9	1
	Srinagar	5,260	40·0	45·0	50·0	56·0	60·0	70·0	73·0	71·0	63·0	57·0	54·0	42·0	56·8	?

* Interpolated.

TABLE IV.—*Monthly Mean Temperatures at places in North-Western India*—contd.

Region.	Place.	Elevation above Sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	
Himaláya and W. Tibet —*contd.*	Murree	6,344	40·3	41·4	50·5	58·1	65·8	72·8	69·6	68·3	67·6	60·5	50·6	44·5	57·5	13—15
	Pangi	8,400	30·5	29·5	36·0	42·5	49·5	62·0	65·5	64·5	62·0	46·0	41·5	36·0	47·1	1
	Dalhousie	6,740	40·7	42·8	52·0	59·0	63·9	65·2	65·4	63·6	62·3	58·2	52·6	45·1	55·9	1—2
	Dharmsala	4,500	44·6	49·4	57·3	68·3	72·3	75·8	70·7	69·6	69·0	64·6	57 7	50·5	62·5	4—5
	Kangra	2,550	49·7	55·4	62·6	68·4	79·0	85·7	78·2	76·0	75·0	67·6	60·6	53·7	67·6	3
	Kotgarh	6,410	42·4	49·9	54·1	60·5	69·1	71·0	68·5	68·0	66·4	57·7	49·4	46·5	58 6	1—3
	Kasauli	6,650	39·6	39·6	54·8	54·2	64·2	69·3	67·2	65·9	66·1	61·1	53·8	45·6	56·8	1—3
	Dagshai	6,020	39·0	53·6	58·0	63·4	69·0	74·3	68·6	67·8	66·6	63·6	56·5	46·7	60·6	1—3
	Simla	6,953	42·4	44·7	50·5	60·1	65·4	69·6	65·7	64·2	62·2	56 8	50·0	45·3	56·4	17—20
	Chakráta	7,052	42·3	43·7	50·7	59·9	64·4	67·7	64·3	64·2	63·1	57·8	51·8	46·2	56·3	13—14
	Mussooree (1)	6,940	41·7	44·2	51·7	59·6	65·6	68·5	64·7	64·1	63·0	57·3	52·0	46·0	56·6	3—14
	Mussooree (2)	5,858	45·6	47·0	57·2	63·5	67·0	70·8	66·4	65·3	65·2	63·0	56·6	47·6	59·6	1—3
	Landour	7,500	37·8	44·1	49·1	56·3	63·2	68·5	65·3	63·9	64·3	56·4	49·4	44·1	55·2	4—5
	Kalsi	1,800	58·3	61·0	62·6	77·7	81·2	86·0	83·7	80·2	77·2	70·8	63·2	59·7	71·8	1—2
	Dehra	2,230	55·3	58·2	66·4	75·9	82·1	84·7	80·1	78·8	77·6	70·6	62·2	56·1	70·7	18—20
	Pauri	5,103	45·9	50·2	57·5	63·7	69·8	74·3	71·7	69·9	68·5	61·6	54·8	47·7	61·3	1—3 (corrected).
	Ranikhet	6,068	46·3	48·7	56·4	65·5	68·0	71·1	67·9	67·3	66·2	61·2	55·2	49·7	60·3	11—12
	Hawalbagh	4,110	47·0	55·0	61·0	66·0	73·0	76·0	78·0	79·0	75·0	69·0	60·0	52·0	65·9	1
	Almora	5,540	46·3	52·2	57·4	64·7	70·3	75·0	73·2	72·5	72·5	65·4	57·9	51·2	63·2	6—7
	Naini Tal	6,460	42·8	45·3	55·5	60·4	66·0	69·1	68·4	67·3	65·4	59·3	52·7	46·6	58·2	10
	Lohughat	5,650	44·5	45·8	52·3	60·9	66·0	71·0	71·1	70·7	68·7	63·1	51·9	46·4	59·4	2—3
	Pithoragarh	5,374	49·1	48·6	62·2	66·3	67·8	70·1	70·4	70·1	70·4	65·3	57·0	55·1	62·7	1—2
	Niti	11,460	...	...	...	...	...	...	58·0	58·0	55·0	...	...	...	?	1
	Katmandu	4,361	45·4	50·3	56·6	61·6	67·5	72·1	73·1	73·1	70·7	64·7	55·6	49·5	61·7	10—11
Afghanistan and Beluchistan.	Cabul	6,780	30·4	32·2	42·0	53·5	61·6	71·3	...	...	...	...	...	...	?	1 (corrected.)
	Quetta	5,500	39·3	45·5	53·0	60·1	69·2	74·9	78·4	75·5	67·9	57·9	45·7	41·6	59 0	5—6
	Khelat	7,160	36·6	42·4	49·4	56·6	64·6	70·0	73·3	68·8	60·8	52·1	41·2	39·3	54·6	24—(corrected.)
	Mitri	500	58·4	60·4	74·4	...	...	...	...	...	...	...	64·5	60·0	?	1
Sind	Jacobabad	186	56 8	62·5	75·4	83·7	92·2	96·1	94·5	90·9	88·0	78·5	64·0	56·4	78·2	4—5
	Hyderabad	134	63·6	67 7	80·6	86·6	91·4	91·1	89·5	86·4	86·3	83·0	72·0	64·0	80·2	5—7
	Kurrachee	49	64·2	67·6	75·2	80·5	84·5	86·8	84·8	82·0	81·6	78·7	73·0	67·4	77·2	24—26
	Mitti	?	...	...	...	...	...	92·7	88·8	88·0	86·6	86·5	80·2	...	?	1—3
Cutch & Gujarat.	Bhuj	395	67·7	71·3	80·8	85·6	89·2	87·5	84·4	82·2	82·1	80·3	74·9	67·3	79·5	5—6
	Rajkot	429	68·3	71·9	80·4	86·8	90·5	88·1	84·1	81·2	81·0	81·2	75·3	70·5	79·9	4—5
	Gogo	Near Sea-level.	67·9	70·6	79·1	84·6	87·1	86·6	82·7	81·3	82·5	82·6	78·2	73·4	79·8	1—3
	Deesa	466	65·4	70·6	78·9	88·4	92·6	91·1	85·0	81·8	81·0	79·5	73·6	68·4	79·7	23—25
	Baroda	120	70·4	70·8	82·4	90·0	92·2	88·1	83·7	82·1	82·2	79·4	76·9	73·0	80·9	9—10
	Surat	36	70·8	73·2	79·7	84·6	86·0	85·7	82·3	81·2	81·4	81·0	76·7	72·6	79·6	4—5
Khandesh, Berar & C. Prov.	Malegaon	1,430	69·1	73·0	80·8	86·3	87·8	84·1	79·9	78·7	78·6	78·1	72·9	69·3	78·2	4—5
	Dhulia	1,000	71·0	75·5	82·0	88·5	92·0	87·5	82·0	80 5	80·0	79·6	74·0	71·0	80·3	6—7

TABLE IV.—*Monthly Mean Temperatures at places in North-Western India*—contd.

Region.	Place.	Elevation above Sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
			°	°	°	°	°	°	°	°	°	°	°	°	°	
Khandesh, Berar, & C. Prov. —*contd.*	Khandwa	1,024	66·3	71·3	81·2	89·1	92·3	87·9	80·6	79·3	78·7	77·8	71·9	66·2	78·6	6—7
	Chikalda	3,656	62·6	66·8	76·6	82·3	82·6	77·7	70·2	68·2	68·6	69·4	65·8	62·4	71·1	4—5
	Buldana	2,132	68·5	72·6	81·1	86·9	87·4	80·8	76·7	75·6	74·9	76·1	71·7	68·1	76·7	7—8
	Akola	930	68·3	73·4	82·5	90·7	93·4	86·2	80·7	79·6	79·1	77·3	71·7	66·9	79·2	8—9
	Amraoti	1,213	69·6	74·1	83·1	90·5	92·0	85·2	80·0	78·3	78·3	77·5	72·7	68·6	79·2	8—9
	Pachmarhi	3,504	57·0	62·8	73·6	81·1	84·1	78·9	71·5	69·7	70·5	67·0	60·4	57·2	69·5	9—10
	Hoshangabad	1,020	65·5	70·8	80·1	89·4	93·4	88·4	79·6	78·6	79·2	77·1	70·8	66·2	78·3	12—13
	Jubbulpore	1,351	61·6	66·3	76·4	86·2	91·2	87·9	79·6	78·7	78·6	74·0	66·6	60·8	75·7	15—17
	Seoni	2,030	63·9	69·1	78·1	85·8	88·7	83·8	76·9	76·1	76·0	72·9	67·1	63·1	75·1	10
	Nagpur	1,025	68·3	73·8	83·0	90·3	94·2	86·8	80·1	80·0	79·6	78·0	72·1	67·4	79·5	12—13
	Chanda	652	68·3	74·4	83·2	90·8	93·8	87·3	80·9	80·3	79·8	77·6	71·4	66·5	79·5	11—12
	Raipur	960	66·8	71·7	80·6	89·2	93·0	86·6	79·8	79·7	79·9	77·9	71·4	66·3	78·6	12—13
	Sambalpur	450	66·7	72·3	81·1	90·4	93·0	87·7	81·1	81·1	81·9	79·6	72·6	66·4	79·5	10—11
	Narsingpur	1,300	64·9	69·1	78·0	88·7	92·0	88·6	80·0	78·3	80·3	77·0	69·0	63·0	77·4	8—9
	Bhandara	850	65·0	70·0	78·5	87·2	89·8	87·9	82·6	80·8	82·2	80·7	74·2	67·0	78·8	6—7
	Wardha	800	68·6	74·0	83·7	92·5	94·8	86·2	80·9	79·0	78·9	79·8	72·8	67·3	79·9	4—5
	Balaghat	1,500 (?)	64·6	70·8	80·5	89·8	91·8	86·5	78·0	78·0	79·3	76·2	69·2	65·3	77·5	6—7
	Mandla	1,490	62·5	67·0	76·5	85·6	90·8	86·4	78·8	77·9	77·6	73·4	66·9	61·6	75·4	11—13
	Chhindwara	2,240	63·1	68·8	77·0	85·3	88·3	83·2	76·3	75·4	75·7	71·9	66·1	62·8	74·5	10—11
	Bilaspur	880	64·1	70·0	77·5	87·8	91·7	87·0	80·2	80·4	82·2	76·9	69·6	65·4	77·7	8—10
	Baitul	2,190	63·9	69·0	77·5	86·3	88·5	82·0	75·2	75·3	76·1	74·5	65·1	61·7	74·6	6—7
Malwa, Bundelkhand, and Western Bengal.	Neemuch	1,640	61·2	67·6	76·0	84·8	88·9	85·8	79·0	77·7	78·1	76·7	69·7	63·8	75·8	9—11
	Indore	1,823	66·2	70·4	77·5	85·3	87·6	81·7	77·3	75·9	76·2	76·6	70·0	66·0	75·9	9—10
	Guna	1,620	61·0	64·0	75·0	85·0	92·0	90·0	80·0	78·0	79·0	75·0	73·0	63·0	76·2	1
	Morar	830	59·7	65·2	75·4	85·0	94·8	93·4	85·5	84·4	83·8	79·0	71·6	62·8	78·4	4
	Jhansi	855	62·0	68·0	78·0	88·0	94·5	92·8	83·9	82·6	82·2	79·9	71·8	63·9	79·0	16—18
	Saugor	1,769	63·3	68·4	78·6	86·7	89·5	86·4	78·0	76·6	77·1	75·8	70·4	64·5	76·3	11—12
	Naugaon	757	60·7	69·2	77·7	87·0	94·2	93·7	84·7	83·7	83·0	78·8	68·6	61·7	78·6	10—12
	Nagod	1,100	61·3	67·0	77·4	86·1	91·2	88·3	82·2	81·5	81·0	76·8	69·3	63·2	77·1	5
	Sutna	1,040	60·9	66·6	77·4	87·5	91·2	91·6	82·7	81·7	81·0	77·1	68·4	60·8	77·2	5—6
	Hazaribagh	2,010	61·5	66·4	75·5	84·0	86·4	82·9	79·2	78·4	78·1	74·5	67·7	61·8	74·7	13—15
	Ranchi	2,170	62·5	68·2	76·5	84·6	83·5	84·4	79·9	79·2	78·7	75·9	67·4	62·7	75·5	12
	Chaibasa	750	64·9	70·1	80·4	87·4	88·5	88·0	84·0	84·2	82·9	80·9	73·7	67·2	79·4	10
Gangetic Plains.	Gya	375	62·9	68·9	78·7	87·8	90·2	88·7	84·2	83·6	83·6	79·6	70·8	64·1	78·6	14—16
	Patna	179	59·7	65·2	76·4	85·7	87·9	87·5	84·5	84·0	83·9	79·6	69·5	61·6	77·1	16—18
	Muzaffarpur	180	58·2	64·9	73·7	82·3	87·2	86·8	84·5	84·1	84·0	79·2	69·6	61·0	76·3	7—9
	Chapra	200	59·7	67·0	75·4	86·4	89·6	86·1	85·1	84·2	82·8	79·1	68·5	60·0	77·0	3—5
	Ghazipur	221	58·9	65·1	76·6	87·3	90·4	91·2	84·6	85·0	84·4	79·0	69·1	59·1	77·6	5—6
	Azamgarh	250	59·8	68·1	78·2	85·8	88·5	89·9	84·5	85·0	84·0	80·0	69·4	61·3	77·9	3—4
	Gorakhpur	256	59·6	65·1	75·0	85·0	87·7	88·2	84·0	83·7	83·2	78·3	68·8	61·2	76·7	17—20

TABLE IV.—*Monthly Mean Temperature at places in North-Western India*—contd.

Region.	Place.	Elevation above Sea-level.	January.	February.	March	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		Feet.	°	°	°	°		°	°	°	°	°	°	°	°	
Gangetic Plains.—*contd.*	Basti	290	59·2	65·5	75·5	82·2	88·3	87·3	84·3	82·5	81·5	78·2	68·5	59·8	76·1	2—3
	Gonda	350	58·9	65·0	75·8	86·5	88·6	88·8	83·6	83·3	82·4	78·3	68·4	60·3	76·7	8
	Fyzabad	330	59·6	66·1	76·2	85·1	90·8	89·5	85·0	84·5	83·3	79·6	68·7	60·7	77·4	5
	Benares	267	59·7	65·6	75·8	85·9	91·3	90·8	85·0	83·8	83·2	77·8	67·4	60·0	77·2	20—23
	Chunar	290	60·1	65·3	77·3	85·6	92·7	89·3	83·7	82·2	81·4	78·2	68·8	60·9	77·2	3
	Allahabad	307	59·6	65·2	77·2	86·5	92·0	91·3	84·9	83·4	82·6	77·2	66·8	59·6	77·2	14—15
	Cawnpore	420	59·2	66·0	76·6	86·0	91·9	92·3	84·9	85·0	84·1	78·5	68·5	60·6	77·8	4—8
	Lucknow	369	59·5	65·6	75·8	87·0	91·3	92·0	86·2	85·1	84·1	78·3	68·1	59·9	77·7	16—17
	Sitapur	450	57·0	62·2	72·7	81·5	88·9	89·2	84·4	83·3	82·5	71·1	66·6	57·9	75·3	4—6
	Bareilly	568	56·7	61·8	71·8	82·5	87·8	89·3	84·1	83·2	82·0	75·7	64·8	57·3	74·8	15—16
	Fatehgarh	440	58·1	67·2	74·4	84·0	91·0	91·2	85·1	84·0	82·9	77·6	68·1	59·5	76·9	10—11
	Etawah	500	58·4	64·8	74·4	83·3	90·9	92·5	86·3	85·4	84·0	77·8	68·5	59·0	77·3	3—5
	Agra	555	58·3	65·2	75·2	86·5	93·6	94·5	86·8	85·1	83·7	78·5	68·3	60·8	78·1	24—26
	Muttra	580	59·6	65·5	74·0	83·4	88·7	92·4	86·4	85·3	84·8	79·6	70·2	62·0	77·7	4—5
	Aligarh	610	58·6	63·3	75·0	83·9	91·4	93·6	87·2	86·3	84·4	78·4	68·3	60·6	77·6	3—5
	Delhi	718	56·6	62·0	72·0	82·4	89·1	92·6	86·4	84·0	83·4	76·9	66·2	58·7	75·8	11—14
	Meerut	737	56·3	62·1	71·4	81·8	88·8	91·7	85·9	84·7	83·4	75·7	65·5	57·4	75·4	20—22
	Moradabad	660	57·5	61·2	73·5	81·4	88·6	89·8	84·5	83·8	84·0	74·9	65·6	58·1	75·2	4—5
	Bijnor	760	56·0	61·2	71·5	81·8	89·1	89·9	84·1	83·5	82·4	74·4	63·9	57·6	74·6	5
	Roorkee	887	55·7	60·3	68·7	80·7	87·3	90·4	84·9	83·4	82·4	74·2	63·4	56·2	74·0	19
	Saharanpur	900	55·5	58·9	70·5	78·5	86·3	91·2	86·1	85·4	82·1	76·2	65·2	58·8	74·7	6
Rajputana.	Ulwar	1,960	54·9	63·0	73·5	79·0	89·8	90·9	85·6	84·2	82·1	73·3	68·5	55·2	75·0	3—4
	Bikanir	750	58·6	63·0	78·0	89·0	94·1	95·1	91·0	86·6	87·8	82·9	68·5	58·9	79·5	3—5
	Bhurtpur	600	59·2	65·9	76·8	84·3	89·3	92·9	88·2	85·4	84·0	78·7	69·4	61·1	78·0	6—7
	Jeypur	1,431	58·8	62·8	75·3	85·0	89·9	91·1	84·3	81·7	82·5	76·8	67·6	60·2	76·4	12—13
	Sambhar	1,254	55·5	61·4	74·6	85·7	91·1	92·6	85·7	82·8	83·1	77·4	65·2	58·3	76·1	10—12
	Ajmere	1,610	57·5	62·9	73·4	83·4	89·2	88·7	82·4	80·6	81·4	77·2	67·1	60·1	75·3	15—16
	Nasirabad	1,460	60·4	64·0	73·1	84·3	91·3	91·2	85·4	81·7	80·5	78·6	69·7	59·5	76·6	6
	Beawar	2,000	55·0	61·9	70·9	84·9	91·6	90·1	83·2	79·8	79·5	74·4	65·7	57·0	74·5	2—4
	Deoli	1,120	61·6	68·2	80·2	86·2	91·3	89·5	80·7	79·2	80·8	76·6	72·5	65·7	77·7	3
	Jhalrapatan	1,240	60·9	68·3	77·7	87·5	93·0	90·6	83·2	81·0	82·4	77·2	68·2	63·0	77·7	4—5
	Kherwara	1,200	64·0	70·0	79·2	88·8	92·7	89·1	82·5	80·0	80·9	78·3	69·9	64·9	78·4	20—22
	Mount Abu	3,945	56·9	61·0	69·4	75·7	79·4	77·1	71·5	68·8	69·2	69·5	64·6	58·9	68·5	15—16
	Erinpura	1,140	55·5	61·9	73·7	84·0	88·9	89·8	84·8	81·4	81·4	75·8	65·3	60·2	75·2	10—14
	Pachbadra	395	59·8	67·0	76·7	88·1	92·5	92·4	89·4	83·0	85·7	80·6	69·0	62·2	78·9	2—3 (corrected.)
Cis-Sutlej Plains.	Sirsa	662	54·9	60·3	72·0	82·7	89·8	93·9	90·2	88·7	86·2	78·5	64·6	55·8	76·4	...
	Bahawalpur	380	54·7	61·7	69·2	80·4	90·2	96·1	92·2	88·0	84·7	76·3	64·8	56·6	76·2	3—6
	Ferozepur	640	54·5	62·7	71·5	79·0	88·5	93·0	89·1	86·2	86·2	76·0	65·2	57·3	75·8	5—8
	Ludhiana	812	52·9	58·2	68·5	79·2	86·2	92·1	87·6	86·3	84·2	75·3	63·0	54·4	74·0	13—16
	Umbala	900	54·5	61·0	69·9	78·4	86·5	91·1	85·8	85·7	84·3	75·0	63·2	56·2	74·3	5—7

Table of IV.—Monthly Mean of Temperature at places in North-Western India—concld.

Region.	Place.	Elevation above Sea-level.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of years.
		Feet.	°	°	°	°	°	°	°	°	°	°	°	°	°	
Panjab.	Hoshiarpur	1,060	52·0	56·9	65·5	78·5	85·0	90·4	84·7	84·1	83·6	75·1	59·1	53·7	72·4	2—5
	Jullundur	800	53·8	59·1	67·4	76·4	81·5	87·4	86·9	84·4	83·9	75·9	65·6	57·9	73·4	1—4
	Amritsar	780	51·5	57·9	67·6	78·4	86·5	90·6	87·4	86·7	83·5	75·6	62·0	54·0	73·5	3—4
	Lahore	732	52·7	59·2	69·6	80·8	88·2	93·6	89·2	87·2	85·3	76·2	64·5	55·3	75·1	18—21
	Mooltan	420	53·6	58·5	71·1	80·9	89·5	93·9	92·4	90·0	86·6	77·4	66·3	55·3	76·3	12—16
	Dera Ghazi Khan	400	51·4	59·7	68·9	78·6	85·2	93·8	91·3	88·3	86·2	76·7	64·5	55·5	75·0	3—4
	Dera Ismail Khan.	573	52·2	56·5	69·4	78·6	87·5	92·8	92·1	90·1	85·9	75·0	61·4	53·5	74·6	13—15
	Shahpur	650	52·8	54·7	65·0	77·9	90·1	95·3	91·6	90·4	88·5	76·6	64·7	55·4	75·3	3—4
	Sialkot	830	51·6	56·3	67·1	78·7	85·7	92·2	87·0	85·2	83·4	74·2	62·5	53·5	73·1	17—19
	Rawal Pindi	1,652	48·7	51·6	62·3	73·2	82·3	88·8	86·9	83·9	79·9	69·6	57·3	49·6	69·5	14—16
	Peshawar	1,110	49·7	52·8	63·2	71·9	81·8	89·4	89·9	87·2	81·5	71·0	58·1	50·4	70·6	5—6
	Thull	2,250	48·9	50·1	62·2	73·6	84·7	89·2	86·0	83·0	79·5	70·9	57·1	49·0	69·5	1 (corrtd).

The mean temperature of Delhi, in this table, is founded on three series of observations, the longest of which, from 1875 to 1881, having been made at the hospital in the city, is considerably too high; while the next longest, extending over parts of 1851, 1852 and 1853 and the whole of 1854, appears, by comparison with surrounding stations, to be too low. The annual means of the three series are :—

1851-54	74·4°
3 years from Sanitary Report	75·6°
1875-81	77·5°
Adopted mean	75·8°

At Simla also, three independent series of observations give results which differ considerably; but this is probably owing to differences of elevation and aspect in the places where the observations were made. The annual means are :—

1841-45	54·6°
1850-56	57·8°
1867-81	56·5°
Adopted mean	56·4°

At several geographically important stations, and at some others, used in computing the rate of vertical decrement, the means, for short periods, have been corrected, by comparison with simultaneous observations, at other stations, similarly situated. Thus, the observations made at Cabul have been corrected by comparison with those of Murree.

At the Trans-Himalayan stations, and in Afghanistan and Beluchistan, that is to say, wherever the influence of the summer monsoon is not felt, the highest temperature of the year is reached in July; as it is in Europe and North America. In the Punjab, Upper Sind, Rajputana and the North-Western Provinces, west of Lucknow, June is the hottest month; while on the Bombay coast and in Malwa, the Central Provinces, Lower Bengal and Behar, where the rains usually set in before the middle of June, the hottest month is May.

Over the greater part of the region here dealt with, the lowest temperature of the normal year occurs in the beginning of January; but, in the Central Provinces, December is normally cooler than January. In these districts, the north-east winds, which usually blow during the cold season, are replaced, for a few days, by warmer south-westerly winds, at times, in January and February, when rain falls in North-Western India; but the precipitation which accompanies these winds in the Central Provinces is not sufficient to lower the temperature appreciably. Accordingly, we find that the lowest temperature is attained in December, when the north-easterly winds are steadiest.

Annual Range of Temperature (Plate XVIII).

From Table IV, it may be seen that the annual range of temperature, as measured by the difference between the mean temperatures of the hottest and coldest months, is greatest at the Trans-Himalayan stations and in Upper Sind and Beluchistan; while it is much less in the Himalaya and at the hill stations in Central India, and least of all on the coast of the Gulf of Cambay. From the meteorological reports of the last four or five years, and other sources, mean values of the absolute range, for several years, at many of the stations in Table IV, have been obtained; and by assuming that, for neighbouring places, the absolute range is proportional to the range of the monthly means, it is possible to arrive at approximate values for the absolute range at nearly all the stations, by a simple application of the Rule of Three. This has been done in drawing up Table V; where the names of stations, at which the absolute range has been found by observation, are printed in small capitals.

Table V.—*Annual Range of Temperature.*

Place.	Annual Range		Place.	Annual Range	
	Of monthly means.	Of extremes.		Of monthly means.	Of extremes.
	°	°		°	°
Yarkand*	61·2	100·9	Chakrata	25·4	63;5
Gilgit	42·0	88·2	Mussooree (1)	26·8	67·0
Leh	43·6	91·4	Mussooree (2)	25·2	63·0
Spiti	43·6	91·4	Kalsi	27·7	66·5
Kanám	37·8	86·9	Dehra	29·4	70·0
Kardong	39·0	89·7	Pauri	28·4	66·5
Srinagar	33·0	75·9	Ranikhet	24·8	58·1
Murree	32·5	70·7	Almora	28·7	67·1
Pangi	36·0	82·8	Naini Tal	26·3	63·1
Dalhousie	24·7	59·3	Lohughat	26·6	63·8
Dharmsala	31·2	73·3	Katmandu	27·7	64·8
Kangra	36·0	85·7	Quetta	39·1	84·5
Kotgarh	28·6	68·9	Kelat	36·7	78·4
Kasauli	29·7	71·6	Jacobabad	39·7	88·4
Simla	27·2	65·6	Hyderabad	27·8	77·7

* One year only.

Place.	Annual Range		Place.	Annual Range	
	Of monthly means.	Of extremes.		Of monthly means.	Of extremes.
	°	°		°	°
Kurrachee	22·6	64·0	Saugor	26·2	66·8
Bhuj	21·9	64·5	Nowgong	33·5	77·1
Rajkot	22·2	71·9	Nagod	29·9	74·7
Gogo	19·8	61·4	Sutna	30·4	75·8
Deesa	27·2	71·0	Hazaribagh	24·9	63·7
Baroda	21·8	56·9	Chaibasa	23·6	60·7
Surat	15·2	47·1	Gya	27·3	70 4
Bombay	11·7	34·5	Patna	28·2	69·6
Malegaon	18·7	70·6	Muzaffarpur	29·0	71·3
Khandwa	26·1	71·8	Chapra	29·9	73·8
Chikalda	20·2	53·0	Azamgarh	30·1	72·0
Buldana	19·3	55·6	Gorakhpur	28·6	70·3
Akola	26·5	69·9	Basti	29·1	71·6
Amraoti	23·4	64·2	Gonda	29·9	73·6
Pachmarhi	27·1	65·9	Fyzabad	31·2	76·7
Hoshangabad	27·9	72·2	Benares	31·6	73·4
Jubbulpore	30·4	75·9	Chunar	32 6	75·6
Seoni	25·6	68·9	Allahabad	32 4	76·5
Nagpur	26·8	69·4	Cawnpore	33·1	76·8
Chanda	27·3	73·9	Lucknow	32·5	76·9
Raipur	26·7	66·7	Sitapur	32·2	75·7
Sambalpur	26·6	68·4	Bareilly	32·6	75·8
Narsinghpur	29·0	74·0	Fatehgarh	33·1	76·8
Bhandara	24·8	64·5	Etawah	34·1	76·0
Wardha	26·5	68·9	Agra	36·2	76·2
Bálaghát	27·4	72·6	Aligarh	35·0	77·0
Mandla	29·2	73·0	Delhi	36·0	79·2
Chhindwara	25·5	68·8	Meerut	35·4	76·6
Bilaspur	27·6	69.0	Moradabad	32·3	75·0
Baitul	26·8	67·0	Bijnor	33·9	77·3
Neemuch	27·7	73·2	Roorkee	34·7	79·2
Indore	21·6	63·2	Saharanpur	35·7	81·4
Guna	31·0	71·3	Ulwar	36·0	77·0
Morar	35·1	76·5	Bickaneer	36·5	75·9
Jhansi	32·5	73·7	Bhurtpur	33·7	76·0

Place.	Annual Range		Place.	Annual Range	
	Of monthly means.	Of extremes.		Of monthly means.	Of extremes.
	°	°		°	°
Jeypur	32·3	74·6	Umbala	36·6	82·3
Sambhar	37·1	75·0	Hoshiarpur	38·4	85·6
Ajmere	31·0	75·2	Amritsar	39·1	86·0
Nasirabad	30·9	75·0	Lahore	40·9	86·6
Jhalrapatan	32·1	75·7	Mooltan	40·3	86·2
Kherwara	28·7	74·7	Dehra Ghazi Khan	42·4	90·7
Mount Abu	22·5	58·7	Dehra Ismail Khan	40·6	89·5
Pachbadra	32·6	76·9	Shahpur	42·5	90·1
Sirsa	39·0	83·9	Sialkot	40·6	88·1
Bahawalpur	41·4	88·5	Rawal Pindi	40·1	87·1
Ferozpur	38·5	82·4	Peshawar	40·2	87·8
Ludhiana	39·2	87·5	Thull	40·3	88·0

Other things being equal, the annual range of temperature should increase with the latitude, from a value but little exceeding the daily range at the Equator, to something very great near the poles. In a general way, the figures in Table V conform to this rule; but they also vary, in a remarkable degree, with the distance from the sea; and especially with the rainfall, the variation in this case being inverse. On the last of the maps appended to this paper (Plate XVIII) lines of equal annual range have been drawn. In almost every respect, they follow the lines of equal rainfall, except that they are shifted slightly to the northward; the region of maximum temperature range, in Sind and Beluchistan, lying about two degrees to the north of the region of minimum rainfall. The zones of minimum temperature range, on the coasts of the Konkan and Bengal, in the Himalayas, the Vindhya and Satpura ranges, and at Mount Abu in Rajputana, all coincide with zones of unusually heavy rain. The only exception to the rule, that regions of heavy rainfall have a small temperature range, appears to be the Rewah country, including the Kaimur range, the upper Sone valley, the vicinity of Jubbulpore and the Amarakantak plateau. This region is represented by very few stations; but there is no reason to doubt the reality of the temperature range given by the observations at Jubbulpore. From these it appears that, the large range is due quite as much to the low temperature of the winter months, as to the great heat of May and June; the region being distinctly cooler than surrounding districts, on the average of the year. Possibly, the fact that this part of the country contains a larger proportion of forest area than any other, may have something to do with its coolness in the winter season, though I am not aware of the existence of any other evidence, to show that forest lands are cooler than the open country in winter. In this part of the world, however, though the term winter may be applied to the cool season, it must not be understood in its ordinary sense.

Variations of Long Period.

The question of a variation of temperature, having a period longer than a year, has been much discussed of late, and Dr. W. Köppen, Mr. E. J. Stone and others have brought forward enough evidence to prove that, in tropical countries at least, the air temperature is very probably subject to a slight variation, the period of which is about eleven years; and which is related inversely to the number of spots seen upon the sun's surface. For all the more important stations, included in the previous tables, at which observations for five years or upwards have been made, I have taken the variations, month by month, from the monthly means, and combined the whole of the results for each year. These mean results are shown in Table VI.

Table VI.—*Variations of Long Period.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Number of stations.
1850	−2·6	−3·5	−1·0	−1·7	+0·3	+1·0	+4·5	+0·2	+0·6	+1·2	+1·0	+1·5	+0·1	1—12
1851	+0·7	−0·4	+0·2	+0·1	+1·4	+0·7	0·0	+0·7	−0·1	+0·7	−0·3	+0·4	+0·3	14—22
1852	−0·5	−2·8	−2·5	−2·1	−3·0	−1·3	−0·8	−1·2	−0·2	+0·2	+1·2	−0·3	−0·6	21—27
1853	−2·0	+1·4	+0·8	−0·6	−0·3	+0·5	−0·8	+1·2	+1·4	+0·1	+1·5	+0·5	+0·6	16—26
1854	+1·7	−1·8	−0·5	+0·2	−0·1	−0·1	0·0	+0·4	−0·1	−0·4	−0·2	+0·2	−0·1	17—24
1855	−2·9	+1·3	−3·1	−3·1	+1·6	+1·4	−1·7	+1·2	−0·5	0·0	−0·1	0·0	−0·5	5—10
1856	+3·1	+1·1	+4·2	+2·1	+1·6	−2·3	−0·2	−0·8	−0·4	+0·2	+0·9	0·0	+0·8	10—14
1857	−0·7	+1·3	+1·4	−2·4	−0·7	−0·5	−0·3	−1·2	−1·7	−0·8	−2·5	−0·6	−0·7	4— 6
1858	−1·1	−0·5	−0·4	+0·3	+0·5	−0·8	−0·5	−0·6	+0·2	−1·2	−0·2	−0·5	−0·4	6— 7
1859	+1·6	+0·9	−1·4	0·0	+0·2	−1·4	+1·1	−1·1	−0·5	−0·5	+0·8	−0·7	−0·1	7— 9
1860	−0·9	+1·0	+1·5	−0·2	+0·6	+1·2	+0·2	+0·3	−0·3	+1·3	−0·7	+0·6	+0·4	4— 6
1861	+0·2	−0·4	−1·2	+0·8	−1·5	−2·0	−1·2	−0·2	−0·3	−0·6	−2·3	−1·0	−0·8	5— 6
1862	−1·7	+1·4	−2·1	−1·1	−0·4	−0·6	−0·2	+0·5	+0·7	−0·4	−0·4	−0·6	−0·4	5— 6
1863	+0·3	−0·1	+0·2	+0·2	+0·9	−1·2	−0·9	−0·4	+0·4	−0·9	−0·8	−0·8	−0·3	7— 9
1864	−1·8	−1·3	−2·3	−1·1	−2·3	−2·0	+0·3	+0·1	+0·7	+0·2	+1·1	+1·6	−0·6	7— 9
1865	+3·2	+0·5	−1·3	−3·2	−0·3	+3·1	+0·8	+1·3	−0·2	+0·2	−0·7	0·0	+0·3	6— 8
1866	+0·2	−1·6	+1·8	−2·3	+0·3	+0·9	+0·9	−0·7	+0·5	+0·9	+1·0	−0·6	+0·1	10—20
1867	+0·6	−2·0	+0·2	−2·0	−1·2	−1·3	+0·2	−0·4	+0·4	−1·3	0·0	−0·6	−0·6	18—23
1868	−1·5	−1·7	−1·9	−1·1	−0·6	−0·7	+2·3	+2·2	+2·2	+1·7	+2·2	+0·9	+0·3	17—25
1869	+1·4	+1·0	−1·4	+1·4	+1·7	+3·2	+0·6	+1·7	−0·1	−1·4	−1·4	+0·4	+0·6	26—31
1870	+0·6	+1·6	−0·7	−1·4	+1·8	−0·7	+0·2	−0·7	−0·6	+1·8	+0·1	−0·5	+0·1	30—35
1871	+0·2	+2·0	+0·7	+0·2	−2·3	−3·5	−0·2	−0·6	−0·2	+1·6	+2·2	+1·3	+0·1	33—38
1872	+0·2	−1·4	+2·7	−0·6	+1·4	+1·4	−0·8	−0·7	−0·8	−0·7	+0·4	+1·2	+0·2	37—39
1873	0·0	+1·6	+0·5	+1·7	−1·8	+2·4	−0·3	−0·3	−0·3	−1·4	0·0	−0·1	+0·2	40—44
1874	−1·9	−1·3	−2·9	+0·7	+1·8	−3·6	−0·4	−1·0	−0·1	+0·3	−1·4	−0·4	−0·9	42—43
1875	−1·2	−1·3	+3·1	+2·4	−0·5	+0·1	−0·4	−1·0	−1·1	−2·0	−0·4	+1·2	−0·1	41—45
1876	+0·8	−0·1	−0·5	−0·2	+1·7	+1·9	−0·5	−0·4	−1·5	−2·2	−0·7	−0·3	−0·2	38—48
1877	−0·1	−3·7	−1·7	−4·3	−2·2	+0·7	+2·5	+3·3	+2·7	−0·3	+3·3	+1·1	+0·1	50—55
1878	−1·6	+1·4	+1·4	−1·6	−3·4	+2·3	+1·4	0·0	+1·2	+2·5	+0·9	−1·3	+0·3	54—55
1879	+1·1	+1·4	+0·4	+1·9	+2·2	−1·6	−0·1	−1·3	−1·1	−1·0	−3·1	−2·4	−0·3	54—55
1880	+1·0	−2·5	+1·8	−3·2	+0·4	+0·7	−1·4	+0·6	−0·8	+1·1	−0·7	−0·6	−0·3	52—54

It is evident, from the column of annual means in this table, that there is no indication whatever of an eleven-year period, or any other, in the temperature anomalies. Nothing, indeed, in connexion with the temperature of India, is more surprising, than the constancy of the annual mean. As regards the north-west of the country, this appears to be chiefly the result of the law mentioned in Vol. I, page 209, that a wet and consequently cool winter is usually followed by a hot and dry summer, and *vice versâ*.

Though the results in Table VI lend no support to Dr. Köppen's conclusion, they cannot be said to controvert it; because the stations, included in the table, lie partly within, but for the most part beyond the Torrid Zone; while the regular variation, discovered by Köppen, was only found at places between the tropics. The results would, moreover, be doubtless more regular, if the registers of the various stations were more nearly equal in length, and if the numbers of stations, contributing to form the averages for the several years, were more nearly equal. For these reasons, the sum of the negative anomalies, during the 32 years, in the table, exceeds the sum of the positive by 2·3°; or to make the positive and negative anomalies nearly equal, the standard from which these variations are counted should be lowered a tenth of a degree.

Vertical Decrement of Temperature and reduction to Sea-level.

In the annual reports on the meteorology of India, it is assumed that, on the plains and plateaux in the interior of the country, the temperature falls 1°F. in 450 feet of ascent, this being the mean rate deduced from a comparison of the observations of Hazaribagh with those of Berhampur, in the Bengal Delta. In the *Indian Meteorologist's Vade-Mecum*, pages 152-157, Mr. Blanford has shown that in most other parts of India the decrease is more rapid, and that it is subject to a well marked annual inequality. The Chutia Nagpur plateau, about Hazaribagh, being probably abnormally hot for its latitude, I have attempted to obtain rates of decrement which will be more generally applicable than that derived from a comparison of Hazaribagh and Berhampur, by comparing stations of unequal elevation in other parts of Northern India. To eliminate, as far as possible, all local horizontal temperature gradients, the observations of the upper station have, in each case, been compared with the mean of several stations around it; these being combined, in such a way, as to make the mean latitude and longitude nearly the same as those of the upper station.

TABLE VII.—*Variation of Temperature with Height in Hindustan.*

Groups of Stations.		Elevations in feet.			Temperature decrement in degrees per 1,000 feet.												
Higher.	Lower.	Higher.	Lower.	Difference.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
Rawal Piudi . .	Peshawar, Sialkot . .	1,652	970	682	2·86	4·38	4·18	3·08	2·13	2·93	2 27	3·37	3·71	4·40	4 40	2·35	3 43
Jeypur, Sambhar, Ajmere . . .	Deesa, Delhi, Pachbadra, Agra, Bickaneer, Jhansi . .	1,432	623	809	3 46	4·45	2·60	2·97	3·21	2·84	3·71	2·59	2·10	3·21	3 71	3·34	3·18
Hazaribagh . .	Chaibasa, 2 Gya . . .	2,010	500	1,510	1·39	1·92	2·52	2·45	2·12	3·71	3 25	3·58	3·52	3·64	2·71	2·18	2·75
Seoni . . .	Nagpur, Jubbulpore . .	2,030	1,188	842	1·31	1·07	1·90	2·85	4·75	4·28	3·44	3·92	3·33	3·68	2·61	1·19	2·86
Mount Abu . .	Deesa, Erinpura, Pachbadra, Kherwara . . .	3,945	803	3,142	1·37	2·04	2·45	3·82	3·91	4·29	4 49	4·07	4·14	2·90	1·56	1.59	3·05
Chikalda . . .	Khandwa, Amraoti . .	3,656	1,119	2,537	2·13	2·32	2·17	2·96	3·78	3·47	3·98	4·18	3·90	3·27	2·56	1·97	3·06
Pachmarhi . .	Hoshangabad, Khandwa, Seoni, Jubbulpore . . .	3,504	1,361	2,143	3·41	3·08	2·52	3·03	3·41	3·78	3·59	3·97	3·55	3·93	4 06	3·22	3·45
Paras Nath* . .	2 Hazaribagh, Berhampore .	4,450	1,362	3,088	2·71	3·09	2·93	2·90	3·50	3·73	3·70	3·57	4·10	3·76	3·25	2·61	3·32
Mean for Plains and Plateaux below 2,500 feet . .		1,781	820	961	2·26	2·95	2·80	2·84	3·05	3·44	3·17	3·36	3·17	3·73	3·36	2·26	3·04
Mean for Hill Ranges over 2,500 feet . . .		3,889	1,161	2,728	2·40	2·63	2·52	3·18	3·65	3·82	3·94	3·95	3·92	3·46	2·86	2·35	3·22

* A mountain in the Hazaribagh District beyond the limits of the map.

On the Rawal Pindi plateau, the temperature differs least from that of the adjacent plains, in the hot weather and in December and January, while the difference is greatest at the beginning and end of the cold weather. There is a similar but less decided variation in the other three of the lower groups: only in these the decrement is least in the cold weather.

The smallness of the decrement, in winter, is doubtless connected with the anticyclonic circulation of the air at that season, as has been pointed out by Mr. Blanford in the work above cited: the cause, to which the movement of the air is to be attributed, being the loss of heat by radiation, which occurs over the plains, almost as efficiently as on the hills and plateaux, when the sky is clear and the absolute humidity of the air is low. The relatively lower temperature of the plateaux, at the end of the rains, is no doubt due to the large proportion of vapour still in the air over the plains, which interferes with nocturnal radiation; and the rapid decrease, observed in February, March and April, at Rawal Pindi, and in May and June at Seoni, is perhaps due to the dust with which the lower strata of the air are loaded; this no doubt acting quite as powerfully as water vapour, in retarding the loss of heat by radiation. In the hot weather the effect of this cause at the North Punjab stations is not observed, because Rawal Pindi is then quite as dusty as Peshawar or Sialkot.

On the hill ranges, from 1,000 to 4,000 feet, the annual variation of the rate of decrease is very regular; attaining its maximum in the rainy season and its minimum in December and January.

On the average of the year, the decrement for 1,000 feet is greater at the higher than at the lower elevations, contrary to what is believed to be the rule in the free atmosphere;* but this, no doubt, is due to the upper stations of the hill ranges being, for the most part, on isolated peaks, which offer but little heating surface to the air. The observed temperature, at these places, must therefore approximate to that which would follow from the law of convective equilibrium; whereas, at the lower stations, the temperature is, to a great extent, determined by local heating of the ground. If we assume that the temperatures, at various elevations up to 4,000 feet, on the table-lands and hill ranges of the interior of Northern India, may be expressed by parabolic formulæ, we get the following rates of decrement for each 1,000 feet of ascent:—

TABLE VIII.—*Vertical Decrement of Temperature in Hindustan.*

Elevation.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0—1,000 feet . .	2·17	3·16	2·98	2·62	2·84	3·19	2·67	2·98	2·68	3·91	3·69	2·20	2·92
1,000—2,000 . . .	2·28	2·90	2·75	2·90	3·25	3·50	3·30	3·46	3·29	3·69	3·28	2·27	3·07
2,000—3,000 . . .	2·40	2·64	2·52	3·18	3·66	3·81	3·93	3·94	3·91	3·47	2·87	2·35	3·22
3,000—4,000 . . .	2·51	2·38	2·30	3·45	4·06	4·12	4·55	4·42	4·52	3·25	2·46	2·42	3·37

For the reduction of temperatures, at stations in the North-West Himalaya, to sea-level, the formulæ given at Vol. I, page 389, may be employed. These were computed from the observations of Roorkee, Dehra, Chakrata and Leh, on the assumption that the

* See Mr. Glaisher's balloon observations in the British Association Report for 1864.

variation in latitude, between these stations, was uniform, and that the vertical temperature curve for each month approximated to a parabola. Since, however, the differences of latitude and elevation, among the four stations selected, are in the same direction and nearly proportional to each other, it is possible that the parts of the temperature variation, dependent upon latitude and elevation respectively, have not been separated in the formulæ, so completely as is desirable; I have therefore attempted to work out values for the decrement with elevation, among the mountains, by a method similar to that now adopted in determining the variation on the plains and table-lands of India.

The following groups of pairs of stations give mean latitudes for the lower and the higher station which do not differ by more than a few miles; and, though the differences of longitude are considerably greater, this does not much matter since the variation of temperature in longitude, is in every month, small :—

GROUP I.

Lower Station.	*Higher Station.*
Sialkot	Rawal Pindi
Sialkot	Dharmsàla
Kángra	Dharmsala
Hoshiarpur	Kángra
Hoshiarpur	Dehra
Dehra	Pauri
Roorkee	Dehra

	Mean *Lat.*		Mean *Long.*		Mean *Elevn.*
	°	′	°	′	feet.
Higher	31	31	76	48	3,250
Lower	31	28	76	11	1,350
Difference	0	3	0	37	1,900.
Mean elevation of group					2,300.

GROUP II.

Lower Station.	*Higher Station.*
Gilgit	Skardo
Srinagar	Skardo
Srinagar	Murree
Rawal Pindi	Murree
Dharmsála	Dalhousie
Dharmsála	Simla
Dehra	Mussooree (Upper)
Pauri	Mussooree do.
Pauri	Ranikhet
Almora	Naini Tal

	Mean *Lat.*		Mean *Long.*		Mean *Elevn.*
	°	′	°	′	feet.
Higher	32	9	76	37	6,730
Lower	32	12	76	35	4,420
Difference	0	3	0	2	2,310
Mean elevation of group					5,575

GROUP III.

Lower Station.	*Higher Station.*
Skardo	Leh
Pángi	Leh
Leh	Spiti
Kánam	Spiti
Kánam	Leh
Chakráta	Kánam
Chakráta	Landour

	Mean *Lat.*		Mean *Long.*		Mean *Elevn.*
	°	′	°	′	feet.
Higher	32	47	77	49	11,060
Lower	32	33	77	22	8,550
Difference	0	14	0	27	2,510
Mean elevation of group					9,805

From these groups we get the following mean rates of decrement per 1,000 feet of ascent :—

TABLE IX.

Group.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
I . . .	1·79	2·11	2·42	3·47	3·79	4·26	3·63	3·79	4·68	3·16	1·47	1·21	2·98
II . .	2·18	2·83	2·73	3·05	3·01	3·51	3·39	3·13	2·86	2·43	2·20	1·89	27·7
III . . .	3·67	3·38	3·27	2·11	2·03	1·67	1·12	1·55	1·51	2·55	3·75	3·90	2·54

According to these results, the rate of decrease of temperature, on the average of the year, diminishes slowly as the height increases ; in the same way, but probably not to the same extent as in the free atmosphere. The mean rate, from the lowest to the highest stations, is 2·764° per 1,000 feet or one degree in 362 feet, which is identical with the rate found at Vol. I, page 388. The monthly mean rates, for each group, are subject to a well marked annual variation, the range of which is greatest at the lowest and highest stations, though nearly opposite in phase in these two groups; while, in the intermediate group, it is similar in phase to that of the lower group, though considerably less in range. If the minor inequalities, which are probably, in great part, due to the insufficient length of the registers at several of the stations, be reduced by a process of smoothing, the annual variation becomes more regular. In the following table, the means of the rate for each month and half the sum for the preceding and succeeding months are given :—

TABLE X.

Group.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
I . . .	1·72	2·11	2·60	3·29	3·83	3·98	3·83	3·97	4·08	3·12	1·83	1·42	2·98
II . . .	2·27	2·64	2·83	2·96	3·15	3·35	3·36	3·13	2·82	2·48	2·18	2·04	2·77
III . . .	3·66	3·42	3·01	2·38	1·96	1·62	1·36	1·43	1.78	2·59	3·49	3·81	2·54

From these numbers, the following decrements for each 1,000 feet up to 12,000 have been computed, on the assumption that the temperatures, at each 1,000 feet of elevation, in any month, form a series of which the third order of differences is constant :—

TABLE XI.—*Vertical Decrement of Temperature in the Himalaya.*

Height.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
0—1,000 feet. . .	1·61	1·85	2·44	3·42	4·11	4·06	3·69	4·26	4·94	3·74	1·88	1·35	3·12
1,000—2,000 „ . .	1·65	1·99	2·53	3·36	3·96	4·04	3·80	4·11	4·45	3·37	1·83	1·37	3·04
2,000—3,000 „ . .	1·74	2·14	2·61	3·29	3·79	3·96	3·83	3·93	3·99	3·06	1·83	1·44	2·97
3,000—4,000 „ . .	1·87	2·29	2·69	3·21	3·61	3·82	3·77	3·71	3·57	2·81	1·89	1·58	2·90

TABLE XI.—*Vertical decrement of Temperature in the Himalaya—contd.*

Height.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
4,000—5,000 feet . .	2·03	2·45	2·76	3·12	3·40	3·63	3·62	3·45	3·19	2·62	2·00	1·77	2·84
5,000—6,000 „ . .	2·24	2·62	2·82	3·02	3·17	3·37	3·38	3·15	2·84	2·49	2·16	2·03	2·77
6,000—7,000 „ . .	2·49	2·79	2·88	2·91	2·92	3·06	3·05	2·81	2·53	2·41	2·39	2·34	2·71
7,000—8,000 „ . .	2·79	2·97	2·93	2·79	2·65	2·69	2·64	2·44	2·25	2·40	2·67	2·72	2·66
8,000—9,000 „ . .	3·13	3·16	2·97	2·56	2·37	2·27	2·14	2·03	2·01	2·44	3·01	3·15	2·60
9,000—10,000 „ . .	3·50	3·35	3·00	2·42	2·06	1·79	1·56	1·58	1·81	2·54	3·40	3·65	2·56
10,000—11,000 „ . .	3·92	3·55	3·02	2·27	1·73	1·25	0·89	1·09	1·64	2·71	3·84	4·21	2·51
11,000—12,000 „ . .	4·38	3·75	3·04	2·11	1·38	0·65	0·13	0·56	1·51	2·93	4·33	4·82	2·47

By summing these up and interpolating for any fraction of a thousand feet, we get the quantities to be added to the observed temperatures at hill stations, to reduce them to sea-level. These quantities should probably vary somewhat with geographical position, having different values in the dry regions of the North-West and in the moister regions of the Eastern Himalaya; but there will be no great error in considering them constant, for as much of the mountain zone as comes within the scope of this paper; especially, as the sea-level value of the air temperature is, under the given conditions, a purely fictitious quantity, corresponding to nothing which actually exists in nature.

SEA-LEVEL TEMPERATURE AND ISOTHERMAL LINES (PLATES XIV TO XVII.)

By means of the rates of decrement, given in Tables VIII and XI, the monthly and annual mean temperatures, in Table IV, have been reduced to sea-level values, and the results are shown in Table XII.

At the end of the table are found interpolated values of the sea-level temperature, for a few points in Afghanistan and Tibet, inserted for the purpose of showing the general direction of the isotherms, in regions beyond the boundary of the map. These values are the means of those given by parabolic interpolation, along the meridians and along the parallels respectively.

The temperature registers of many places in the Himalaya, being for very short periods, the monthly means are subject to a good deal of doubt; and even the annual means of some stations are probably a degree or more in error. In the table, therefore, while the temperatures of the regular observatories have been treated independently, the other stations have in many cases been grouped together: and in drawing the charts, the mean sea-level temperature of any group of stations has been assigned to a point lying in the centre of the group. The stations on the plains have all been treated independently, as regards Table XII; but, in drawing the charts, I have not hesitated occasionally to

disregard the figures for stations of the third order where these seemed abnormally high or low, in comparison with other places in the vicinity.

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level.*

STATION.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Yarkand	27·8	39·7	55·2	78·0	85·5	92·4	97·5	94·6	78·7	57·6	42·8	30·3	65·0
Gilgit	48·7	55·7	66·1	76·0	84·9	95·3	95·5	94·7	86·9	74·3	60·2	48·5	73·9
Srinagar													
Skardo	47·6	55·9	64·5	74·0	83·6	92·6	94·8	94·1	85·1	73·6	57·6	45·6	73·6
Leh	46·3	54·1	65·1	77·0	83·4	90·7	93·0	93·2	87·9	74·1	61·6	52·2	73·3
Spiti	51·7	59·3	65·3	76·4	84·5	91·9	95·4	92·7	88·9	77·5	61·7	52·8	74·8
Kanam													
Kardong													
Murree	52·3	55·7	67·3	78·5	88·8	96·7	92·7	91·9	91·5	79·4	63·0	54·8	76·0
Pangi	50·3	58·0	67·1	74·2	80·5	89·6	94·5	92·8	88·0	73·6	63·4	53·1	73·8
Kardong													
Dalhousie	53·4	59·2	69·3	80·2	88·9	93·3	88·4	87·3	87·1	77·8	65·8	56·9	75·6
Dharmsála													
Kangra													
Kotgarh	52·4	62·1	72·5	79·9	90·5	95·5	91·3	90·9	90·3	79·8	65·6	56·7	77·3
Kasauli													
Dugshai													
Simla	55·9	60·7	69·1	82·3	90·2	95·4	90·7	89·5	87·6	77·2	63·9	57·0	76·6
Chakráta	56·1	60·0	69 6	82·4	89·5	93·8	89·6	89·7	88·7	78·4	65·9	58·2	76·8
Mussoorée (1)	54·8	60·6	70·8	81·4	89·6	94·5	89·9	89·2	89·1	78·8	66·1	57·2	76·8
Mussooree (2)													
Landour													
Kalsi	61·2	64·4	67·1	83·8	88·6	93·3	90·4	87·7	85·7	77·2	66·5	62·1	77·3
Dehra	59·0	62·7	71·9	83·2	91·0	93·7	88·5	88·1	86·9	77·4	66·3	59·2	77·3
Pauri	55·0	61·2	70·8	80·4	89·0	94·2	90·7	89·7	88·9	77·4	64·5	55·4	76·4
Ranikhet	57·6	62·2	72·4	84·6	90·2	94·2	90·2	90·1	89·3	79·5	67·0	59·4	78·1
Almora	55·3	63·9	71·7	81·1	89 9	94·3	93·5	94·5	93·2	82·4	68·1	58·9	78·9
Hawalbagh													
Naini Tal	55·1	59·9	72·7	81·2	89·4	93·4	91·9	91·2	89·5	78·5	65·4	57·2	77·1
Lohughat	56·8	59·2	71·7	81·5	87·4	91·7	91·2	91·4	91·4	81·2	65·0	59·2	77·3
Pithoragarh													

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level*—contd.

STATION.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Miti	...	...	...	...	...	...	90·4	90·8	88·0	...	...	...	...
Katmandu . . .	53·0	59·5	67·9	76·0	84·2	89·3	89·5	90·3	88·8	78·6	63·8	55·9	74·8
Cabul	43·5	47·7	60·1	75·2	85·9	96·6	...	...	...	...	...	...	...
Thull	51·6	54·5	67·8	81·2	93·7	98·3	94·4	92·4	89·9	78·8	61·3	52·1	76·3
Quetta	49·3	57·5	64·7	78·0	89·6	96·1	98·8	96·5	89·5	74·9	56·2	50·1	75·1
Kelat	50·7	59·0	68·6	79·4	90·0	96·4	98·9	94·6	86·5	73·0	55·6	51·6	75·4
Mitri	59·5	62·0	75·9	...	...	...	...	...	...	...	66·3	61·1	?
Jacobabad . . .	57·2	63·0	76·0	84·2	92·7	96·7	95·0	91·4	88·5	79·2	64·7	56·8	78·3
Hyderabad . . .	63 9	68·2	81·1	87·0	91·8	91·6	89·9	86·8	86·7	83·7	72·6	64·6	80·7
Kurrachee . . .	64·3	67·8	75·4	80·6	84·6	87·0	84·9	82·1	81·7	78·9	73·2	67·5	77·3
Mitti	...	...	...	...	...	92·7	88·8	88·0	86·6	86·5	80·2	...	?
Bhuj	68·6	72·6	82·0	86·7	90·3	88·8	85·4	83·4	83·1	82·3	76·3	68·1	80·6
Rajkot	69·3	73·3	81·7	88·0	91·8	89·5	85·2	82·5	82·1	82·8	76·8	71·4	81·2
Gogo	67·9	70·6	79·1	84·6	87·7	86·6	82·7	81·3	82·5	82·6	78·2	73·4	79·8
Deesa	66·4	72·1	80·2	89·6	93·9	92·6	86·2	83·2	82·2	81·3	75·3	69·4	81·0
Baroda	70·6	71·1	82·7	90·3	92·5	88·4	84·0	82·4	82·5	79·8	77·3	73·2	81·2
Surat	70·9	73·4	79·9	84·7	86·1	85·9	82·4	81·3	81·5	81·2	76·9	72·7	79·7
Malegaon . . .	72·3	77·5	85·0	90·3	92·2	88·8	84·0	83·2	82·7	83·6	77·0	72·5	82·4
Dhulia	73·2	78·7	85·0	91·1	94·8	90·7	84·7	83·5	82·7	83·5	77·7	73·2	83·2
Khandwa	68·5	74·6	84·3	91·8	95·1	91·0	83·4	82·4	81·4	81·0	75·7	68·4	81·5
Chikalda	71·1	77·1	86·4	93·3	95·0	90·9	83·1	81·5	81·5	82·6	77·3	70 8	82·5
Buldana	73·3	79·1	87·2	92·8	94·0	88·0	83·2	82·5	81·4	84·1	79·1	72·9	83·1
Akola	70·4	76·4	85·3	93·1	96·0	89·2	83·1	82·4	81·5	80·8	75·4	68·9	81·9
Amraoti	72·3	76·0	86·7	93·7	95·5	89·1	83·4	82·0	81·7	82·1	77·1	71·3	82·6
Pachmarhi . . .	65·1	72·7	83·0	91·5	95·9	91·4	83·7	82·3	82·6	797	71·5	65·2	80·4
Hoshangabad . . .	67·7	74·1	83·2	92·1	96·2	91·7	82·4	81·7	81·9	81·1	74·6	68·4	81·3
Jubbulpore . . .	64·6	70·5	80·3	89·9	95·1	92·4	83·4	83·0	82·4	79·2	71·4	63·8	79·7
Seoni	68·5	75·3	83·9	91·4	94·9	90·6	83·0	82·6	82·1	80·6	74·2	67·8	81·2
Nagpur	70·5	77·1	86·1	93·0	97·0	90·1	82·9	83·1	82·3	82·0	75·9	69·6	82·5
Chanda	69·7	76·4	85·2	92·6	95·6	89·3	82·6	82·2	81·5	80·1	73·8	67·9	81·4
Raipur	68·9	74·7	83·5	91·7	95·6	89·7	82·3	82·6	82·4	81·5	74·9	68·3	81·3
Sambulpur . . .	67·7	73·8	82·4	91·6	94·3	89·1	82·3	82·5	83·0	81·3	74·2	67·4	80·9
Narsinghpur . . .	67·8	73·1	81·8	92·2	95·7	92·9	83·6	82·4	83·9	82·0	73·3	65·9	81·2
Bhandara . . .	66·9	72·7	81·1	89·4	92·2	90·6	84·8	83·3	84·4	84·0	77·2	68·8	81·3

TABLE XII.—*Monthly and Annual Mean Temperatures reduced to Sea-level*—contd.

Station.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Wardha	70·4	76·6	86·1	94·6	97·0	88·8	83·0	81·4	81·0	82·9	75·6	69·0	82·2
Balaghat	67·9	75·5	84·9	93·8	96·2	91·4	82·4	82·7	83·6	81·9	74·5	68·6	81 9
Mandla	65·8	71·7	80·9	89·6	95·2	91·3	83·2	82·6	81·9	79·1	72·2	64·9	79·9
Chhindwara	68·1	75·7	83·6	91·7	95·4	90·9	83·3	82·8	82 7	80·4	74·0	67·8	81·4
Bilâspur	66·1	72·9	80·2	90·1	94·2	89·9	82·5	83·1	84·5	80·3	72·8	67·3	80·3
Baitul	68·8	75 8	83·9	92·5	95·4	89·5	82·0	82·5	82·9	82·8	72·8	66·6	81·3
Neemuch	64·9	72·6	80·8	89·3	93·8	91·2	83·8	83·1	82·9	83·0	75 5	67·5	80·7
Indore	70·2	75·9	82·7	90·2	93·1	87·8	82·6	81·8	81·6	83·5	76·3	70·0	81·3
Guna	64·6	68·9	79·7	89·4	96·8	95·3	84·7	83·3	83·7	81·2	78·7	66·6	81·1
Morar	61·5	67·8	77·8	87·1	97·1	96·0	87·7	86·8	86·0	82·2	74·7	64·6	80·8
Jhansi	63·9	70·7	80·5	90·2	96·9	95·5	86·2	85·1	84·5	83·2	75·0	65·8	81·5
Saugor	67·2	73·9	83·8	91·6	94·9	92·3	83·3	82·3	82·4	82·6	76·7	68 5	81·6
Nowgong	62·4	71·6	80·0	89·0	96·4	96·1	86·7	86·0	85·0	81·8	71·4	63·4	80·9
Nagod	63·8	70·5	80·7	89·0	94·4	91·6	85·2	84·8	84·0	81·1	73·3	65·7	80·3
Sutna	63·2	69·9	80·5	90·2	94·2	94·9	85·5	84·8	83·8	81·2	72·2	63·1	80·3
Hazaribagh	66·0	72·5	81·2	89·5	92·5	89·6	85·2	84·8	84·1	82·1	74·7	66·3	80·7
Ranchi	67·3	74·8	82·7	90·6	92·2	91·7	86·5	86·2	85·3	84·0	74·9	67·5	82·0
Chaibasa	66·5	72·5	82 6	89·4	90·6	90·4	86·0	86·4	84·9	83·8	76·4	68·8	81·4
Cuttack	70·9	75·1	82·0	86·9	88·5	86·3	83·6	83·2	83·0	81·0	74·6	69·9	80 4
Gya	63·7	70·1	79·8	88·9	91·3	89·9	85·1	84·7	84·5	81·0	72·1	64·9	79·7
Patna	60·1	65·8	77·0	86·2	88·4	88·1	85·0	84·5	84·4	80·3	70·2	62·0	77·7
Darbhanga	60·8	64·4	74·2	83·8	85·7	85·3	84·1	83·6	83·6	79·5	71·4	62·5	76·6
Mozaffarpur	58·6	65·4	74·3	82·9	87·8	87·3	85·0	84·6	84·5	79·9	70·4	61·5	76·9
Chapra	60·1	67·6	76·0	87·0	90·2	86·7	85·6	84·8	83 3	79·9	69·3	60·4	77·6
Ghazipur	59·4	65·8	77·3	87·9	91·1	92·0	85·2	85·7	85·0	79·9	69·9	59·6	78·2
Azamgarh	60·3	68·9	78·9	86·5	89·2	90·7	85·2	85·7	84·7	81·0	70·3	61·9	78·6
Gorakhpur	60·1	65·9	75·7	85·7	88·4	89·0	84·7	84·4	83·9	79·3	69·7	61·8	77·4
Basti	59·9	66·5	76·4	83·0	89·1	88·3	85·1	83·4	82·3	79·4	69·6	60·5	77·1
Gonda	59·6	66·1	76·8	87·4	89·6	89·9	84·5	84·3	83·3	79·6	69·7	61·0	77·9
Fyzabad	60·3	67·2	77·2	86·0	91·8	90·6	85·9	85·5	84·2	80·9	70·0	61·6	78·1
Benares	60·2	66·5	76·6	86·7	92·1	91·7	85·8	84·6	84·0	78·9	68·4	60·6	78·0
Chunar	60·7	66·3	78·1	86·4	93·5	90·3	84·5	83·1	82·2	79·3	69·9	61·6	78·0
Allahabad	60·3	66·2	78·1	87·3	92·9	92 3	85·7	84·3	83·4	78·4	67·9	60·3	78·1
Cawnpore	60·1	67·4	77·8	87·1	93·1	93·6	86·0	86·2	85·1	80·3	70·0	61·6	79·0

Table XII.—Monthly and Annual Mean Temperatures reduced to Sea-level—continued.

Station.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Lucknow	60·3	66·8	76·9	88·0	92·4	93·2	87·2	86·2	85·1	79·7	69·5	60·7	78·8
Sitapur	58·0	63·7	74·0	82·7	90·2	90·6	85·6	84·6	83·6	78·7	68·2	58·9	76·7
Bareilly	57·9	63·6	73·5	84·0	89·4	91·1	85·6	84·9	83·5	77·9	66·9	58·6	76 5
Fatehgarh	59·1	68·7	75·7	85·2	92·3	92·6	86·3	85·3	84·0	79·3	69·7	60·5	78·3
Etawah	59·5	66·4	75·9	84·6	92·3	94·1	87·6	86·9	85·3	79·7	70·3	60·1	78·8
Agra	59·5	66·9	76·8	87·9	95·2	96·3	88·3	86·7	85·2	80·7	70·8	62·0	79·7
Muttra	60·9	67·4	75·8	85·0	90·4	94·3	88·0	87·1	86·4	81·9	72·4	63·4	79·5
Aligarh	59·9	65·2	76·8	85·5	93·1	95·5	88·8	88·1	86·0	8·07	70·5	61·9	79·3
Delhi	58·1	64·2	74·1	84·2	91·1	94·8	88·2	86·1	85·2	79·7	68·8	60·2	77·9
Meerut	57·9	64·4	73·6	83·7	90·9	94·0	87·8	86·9	85·3	78·6	68·2	59·0	77·6
Moradabad	58·9	63·2	75·5	83·2	90·4	91·8	86·2	85·7	85·7	77·4	68·0	59·5	77·2
Bijnor	57·7	63·6	73·8	83·8	91·3	92·3	86·1	85·7	84·4	77·3	66·6	59·2	76·8
Roorkee	57·7	63·1	71·3	83·0	89·8	93·2	87·3	86·0	84·8	77·7	66·7	58·2	76·6
Saharanpur	57·6	61·8	73·2	80·9	88·9	94·1	88·6	88·1	84·6	79·8	68·6	60·9	77·4
Ulwar	59·2	68·9	79·1	84·4	95·7	97·4	91·4	90·4	87·9	80·5	75·3	59·6	80·9
Bickaneer	60·3	65·4	80·3	91·0	96·3	97·5	93·0	88·9	89·8	85·9	71·3	60·6	81·7
Bhurtpore	60·5	67·8	78·6	85·9	91·0	94·8	89·8	87·2	85·6	81·0	71·6	62·4	79·9
Jeypore	61·9	67·2	79·6	88 9	94·1	95·8	88·4	85·2	86·6	82·3	72·9	63·4	80·6
Sambhar	58·2	65·3	78·3	89·0	95·0	96·7	89·2	86·6	86·6	82·3	69·7	61·1	79·8
Ajmere	61·1	67·8	78·1	87·8	94·0	94·0	87·1	85·9	86·1	83·4	72·8	63·7	80·1
Nasirabad	63·6	68·5	77·5	88·	95·6	96·0	89·6	86·3	84·7	84·2	75·1	62·8	80·9
Beawar	59·5	68·0	76·6	90·4	97·7	96·8	89·2	86·2	85·5	82·0	72·7	61·5	80·5
Deoli	64·1	71·8	83·6	89·2	94·4	93·2	83·8	82·7	83·9	80·9	76·6	68·2	80·7
Jhalrapatam	63·6	72·2	81·4	90·8	96·9	94·7	86·7	84·8	85 9	82·1	72·7	65·8	81·4
Kherwara	66·6	73·8	82·8	92·0	96·8	93·1	85·9	83·7	84·3	83·1	74·3	67·6	82·0
Mount Abu	66·1	72·0	79·9	87·7	93·1	91·6	85·8	83·5	83·5	83·7	76·8	68·0	81·0
Erinpura	58·1	65·6	77·2	87·1	92·1	93·6	88·0	85·0	84·6	80·2	69·6	62·8	78·6
Pachbudra	60·7	68·3	77·9	89·1	93·6	93·7	90·4	84·2	86·7	82·1	70·4	63·0	80·1
Sirsa	56·3	62·4	74·0	84·8	91·8	96·0	91·9	90·7	87·9	81·1	67·1	57·2	78·4
Bhawalpur	55·5	62·9	70·3	81·4	91·3	97·3	93·2	89·1	85·7	77·7	66·2	57·4	77·3
Ferozepore	55·9	64·7	73·5	80·8	90·3	95·0	90·8	88·1	87·9	78·5	67·6	58·7	77·8
Ludhiana	54·7	60·7	70·9	81·3	88·5	94·7	89·7	88·7	86·4	78·4	66·0	56·2	76·3
Umbala	56·5	63·8	72·5	80·7	89·0	93·9	88·2	88·3	86·7	78·5	66·5	58·2	76·9
Hoshiarpur	54·4	60·3	68·7	81·3	88·1	93·8	87·6	87·3	86·5	79 3	63·0	55·5	75·4

Table XII.—Monthly and Annual Mean Temperatures, reduced to Sea-level—concluded.

Station.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Jullundur . . .	55·6	61·7	69·8	78·5	83·8	90·0	89·0	86·8	86·1	79·1	68·6	59·7	75·8
Amritsar . . .	53·3	60·4	70·0	80·5	88·8	93·1	89·5	89·1	85·6	78·7	64·9	55·8	75·8
Lahore	54·3	61·5	71·8	82·7	90·3	95·9	91·1	89·4	87·2	79·1	67·2	56·9	77·3
Mooltan	54·5	59·9	72·3	82·0	90·7	95·2	93·5	91·2	87·6	79·0	67·8	56·2	77·5
Dera Ghazi Khan . .	52·3	61·0	70·1	79·7	86·3	95·1	92·3	89·5	87·2	78·2	65·9	56·3	76·3
Dera Ismail Khan . .	53·4	58·3	71·1	80·1	89·1	94·6	93·6	91·8	87·4	77·2	65·5	54·8	76·3
Shahpur	54·2	56·7	67·0	79·7	91·9	97·3	93·3	92·3	90·2	79·1	67·1	56·8	77·3
Sialkot	53·4	58·9	69·5	80·8	88·0	94·8	89·2	87·6	85·6	77·4	65·6	55·3	75·5
Jhelam	51·4	55·7	65·9	74·2	83·5	93·0	89·3	87·5	87·1	78·7	68·0	53·6	74·2
Rawal Pindi . . .	52·4	56·6	67·1	77·7	87·2	94·2	91·7	89·2	84·7	75·9	63·1	53·3	74·4
Peshawar . . .	52·2	56·3	66·5	74·8	85·0	92·9	92·9	90·5	84·5	75·3	62·1	52·9	73·8
Interpolated values.													
Meridian of 68° E, Lat. 32	45·3	52·5	60·3	74·2	87·3	96·3	98·5	97·2	91·5	72·7	59·7	46·8	73·5
Meridian of 68° E, „ 34	40·9	47·0	58·1	73·7	84·6	95·8	100·0	100·0	87·4	71·0	57·5	44·1	71·7
Meridian of 68° E, „ 36	37·5	41·5	56·0	73·2	81·9	94·5	101·5	98·8	84·0	68·2	53·9	39·5	70·0
Meridian of 80° E, Lat. 32	50·0	56·5	64·5	74·0	83·5	91·5	94·5	93·0	87·5	75·7	60·6	49·5	73·4
Meridian of 80° E, „ 34	45·5	50·4	61·7	72·7	83·0	91·0	97·2	93·7	83·9	72·0	59·2	46·5	71·4
Meridian of 80° E, „ 36	42·0	44·5	56·7	71·4	83·0	91·5	99·9	95·0	80·5	65·7	1·6	41·5	68·4
Meridian of 84° E, Lat. 30	50·5	53·4	64·0	74·7	83·5	87·8	94·6	92·8	86·9	75·0	61·5	50·0	72·5
Meridian of 84° E, „ 32	45·3	47·8	61·5	71·4	82·7	87·2	100·3	95·5	84·4	73·4	59·2	45·0	70·9
Meridian of 84° E, „ 34	40·8	44·4	57·4	68·6	82·0	87·7	102·6	98·0	82·0	66·0	54·8	41·5	68·8

The temperatures, for each month and for the whole year, as given in this table, have been laid down on thirteen maps (Plates XIV to XVII); and lines have been drawn through places of equal sea-level temperature. The map for the year (Plate XIV), is on a moderately large scale, occupying a whole sheet; and on it, lines have been drawn for each degree: the monthly maps are on smaller scale, four to each sheet, and on these, lines have been drawn for every two degrees difference of temperature. On these smaller maps, as printed, only the more important stations are shown, but the isotherms were first drawn on larger maps, in which all the stations appeared.

On the average of the year, the hottest part of the country, over which our maps extend, is the northern part of the Deccan and Khandesh. A slightly sinuous line, running north-north-west, from Dhulia through Neemuch, Bickaneer, and Shahpur to Thull and the Kuram valley, may be called the thermal equator, or more correctly the line of greatest

temperature anomaly; being everywhere hotter than places east or west of it, except in the Aravalis and South-Eastern Rajputana; where it is broken through by a relatively cool region. Upper Sind and Kachh-Gandava are also relatively hot regions; while the hill country occupied by the Marris, Bugtis and other tribes, between Jacobabad and Dehra Ghazi Khan, appears to be cooler than the average of surrounding places. Unfortunately, we have no observations from this region, though troops were recently stationed, for more than a year, at Vitakri and Thull-Chotiali.

Other parts of the country, which seem cooler than the average, are the vicinity of the Gulf of Cambay, the Kaimur range and Jubbulpore region and the Peshawar valley. A remarkable region of unusually high temperature is found in the Kumaun Himalaya; especially on the inner ranges, as indicated by the observations of Ranikhet, Almora and Pithoragarh. The Chutia Nagpur plateau also appears to be warmer than either the Bengal delta, Orissa, or the Sone valley.

Within India proper, between the 20th and 34th parallels, along the line of highest temperature, the mean sea-level temperature decreases from 84° to 74°F., or the average rate of decrease is about 0·7°F. for one degree of latitude. Between Aurangabad and Yarkand, the decrease is about 19°F. in 18½° of latitude, or a little over 1°F. for each degree of latitude. Along the meridian of 80°E. from 20° to 28°N. the temperature diminishes from 82° to 76°F. or 0·75° for one degree of latitude.

We may therefore take the average rate of decrease for North-Western India to be about three quarters of a degree for each degree of increased latitude, while in the Trans-Himalayan regions the rate exceeds 1°F.

The relatively hot regions, above enumerated, agree in one other character—they are all regions of light rainfall; and the cool regions have all a rainfall above the average. If we assume that the temperature would diminish uniformly with the latitude, but for the influence of the rainfall, and that the further decrease is proportional to the amount of the annual rainfall, we may express, approximately, the sea-level temperature of any place in the plains of North-Western India, by the formula,

$$T.=88°-0·7°(\lambda-20°)-0·12°R,$$

where R is the annual rainfall in inches. In Kathiawar, Cutch and Lower Sind, the temperatures are less than those calculated by the formula; because, though the rainfall of these countries is slight, the temperature is moderated by the sea-breeze.

The chief characteristics of the temperature distribution, in each month of the year, are as follows:—

January, Plate XV.—In this month, the sea-level temperature ranges from 73·2° at Dhulia and 73·3° at Buldana to 54·4° at Peshawar, or through 19° in North-Western India. In Afghanistan, it ranges from 49·3° at Quetta to 43·5° at Cabul; while, in the Upper Indus valley, it varies between 46° and 48°; and at Yarkand is probably below 30°.

Upper Sind, the desert between Jesalmir and Bickaneer, and the Central Punjab are relatively warm regions, notwithstanding the low temperature of the nights; while the Aravali region, the Eastern Panjab, and the middle Ganges valley, between Allahabad and Benares, together with the Kaimur range, the Sone valley and South Rewah, are relatively cool. On account of these anomalies, the isotherms, while, on the whole, following the parallels of latitude, assume a very sinuous or wavy appearance. The

greatest deviation from parallelism is in the Punjab, where the lines bend far to the north: the plains of India in winter, where protected from northerly winds by the Himalaya, being much warmer than either Afghanistan or Tibet In the Indus valley, the isotherms run nearly parallel to the river, *i. e.*, nearly north and south; the temperature of the open plains, near Dehra Ghazi Khan, Mooltan and Bhawalpur, being reduced by nocturnal radiation, quite as much as at Peshâwar, Sialkot and Lahore; though these are from two to four degrees further north.

In the Dehra Dun, and probably also in the sub-montane valleys of similar structure to the west of the Jumna, the actual mean temperature of January is almost identical with that of the plains 1,200 and 1,400 feet below, and the sea-level temperature of the Dun is consequently higher than that of the plains. The reason of this peculiarity, the same which sometimes causes an inversion of the normal variation of temperature in an anticyclone, has been pointed out at Vol. I, page 386.

February, Plate XV.—In February, the highest temperature in the part of India covered by the map, is 79·1° at Buldana; and the lowest 56·3° at Peshawar; the range being thus 23°, or four degrees greater than in January. In Berar and Khandesh, by the middle of February, there are distinct indications of the approach of the hot season; while, in the extreme north, the temperature of February differs but little from that of the previous month. In the Upper Indus valley, however, and at Yarkand, where the winter snows are inconsiderable and do not lie long on the ground, the sea-level temperature of February is 8° or 10° higher than that of January.

In Kathiawar and Cutch, the temperature rises rapidly during February, as it does in the Deccan and Khandesh; but between these two regions, round the shores of the Gulf of Cambay, there appears to be a relatively cool area. The observations taken at Sirsa, on the border of the desert, to the north-west of Delhi, show that the country round that station is cooler, in February, than places like Ferozepore and Umbala, which lie further north.

The banks of the Ganges near Allahabad, Benares and Chunar remain cooler than surrounding districts, throughout February; the sea-level temperature being little above 66°; while, to the north, between Rae Bareli and Azamgarh, there is a narrow zone, in which it probably exceeds 68° F.

March, Plate XV.—In March, the hottest of the regular meteorological stations in our maps is still Buldana, and the coolest in India proper is Peshawar. The sea-level temperatures of these two places are 87·2° and 66·5° respectively, the range being over 20°. At Yarkand, the temperature has risen to 55·2°. In the Himalaya and the Northern plains, the isothermal lines follow the same general directions as in the two preceding months; but, in the south, the area of highest temperature is much widened out eastwards, and includes the whole of the Berar plain as far as Nagpur.

In Western Rajputana the lines pursue a very sinuous course, which, in the absence of observations from the Khairpur, Jesalmir and Jodhpur States, must be treated as somewhat uncertain. The temperature of Hyderabad, at the head of the Indus delta, exceeds 81°, and at Jacobabad, on the Upper Sindh frontier, it is as high as 76°; while it is below 65° at Quetta. This makes the decrease of temperature, in the direction of the Bolan Pass, very rapid. Between Bickaneer, Ulwar and Jeypore, in Northern Rajputana,

the temperature, at sea-level, exceeds 80°; while, further south, at Pachbudra, Erinpura, Beawar and Ajmere, it is apparently below 78°.

On the west coast, the isotherms run as nearly as possible parallel to the coast line, each one making a bend northwards in the Gulf of Cambay.

April, Plate XV.—Parts of the Berar and Nagpur plain, in this month, have a temperature exceeding 94°, while, at Peshawar, which still remains the coolest place in India, the temperature is 74·8°. The difference between Peshawar and Buldana is now reduced below 20°, or is about the same as in January. At Cabul, the sea-level temperature is higher than at Peshawar, and at Yarkand it has risen to 78°.

The isothermal lines, in this month, are less regular than in January, February or March. The line of 92° pushes a great loop to the north-east, to include Hoshangabad and Narsingpur in the Narbada valley. The lines of 90°, 88° and 86° are similarly thrown up to the north-east, by the high temperature of Bundelkand, the Lower Ganges-Jumna Doab and Southern Oudh; while the high temperature of the Bundelkand region culminates in a local maximum, exceeding 90°, at Jhansi. Other local maxima are found on the Chutia Nagpur plateau and Bickaneer, and perhaps also at Kherwara in Mewar. The Aravali chain has a sea-level temperature below 88°, while the surrounding districts have temperatures between 89° and 90°. In the north of Kashmir and Baltistan there is probably, in this month, an area of relative cold; the snow there lying longer than in Ladakh and Rupshu to the east and south-east. On the west coast, the isotherms follow the outline of the land as in March.

May, Plate XVI.—The region of highest temperature, in this month, is shifted further to the east, the hottest place being Nagpur, with a sea-level temperature of 97°. With the exception of Bombay and Kurrachee on the coast, Peshawar is still the coolest place on the Indian plains, its temperature, in this month, being 85°. The temperature range from south to north, over 14° of latitude, is thus only 14° in May. The mountains and table-lands, which bound the Indian plains on the north, increase rapidly in temperature during May. The sea-level temperature at Cabul and Yarkand exceeds 85°, while at Quetta and Kelat it reaches 90°.

The isotherm of 96°, in the south, includes East Berar, Nagpur and the Chhattisgarh plain. To the north-west, it includes three independent areas in the Narbada valley, Bundelkand and North Rajputana; the four areas being separated by the Mahadeva hills, the Vindhya and the Aravali range. As in the preceding month, the greater portion of this latter range constitutes a relatively cool area, enclosed in a separate isotherm, which, in May, extends into south-east Rajputana as far as Neemuch. The isotherms project long loops into the Kachh-Gandava plain, the Western Punjab and the Himalayan range.

The last-mentioned characteristic is very remarkable; stations at the foot of the mountains, like Peshawar, Rawal Pindi, Sialkot and Hoshiarpur, being decidedly cooler when allowance is made for elevation, than adjacent places on and behind the first high ridge. It may be supposed that the corrections for elevation applied to the temperatures for this month are too great; but the almost identical sea-level values for Roorkee, Mussooree, Chakrata and Ranikhet show that the allowance for elevation is probably not far wrong.

June, Plate XVI.—With the advent of the rains, in the early part of this month, the temperature of the west coast and Central India rapidly falls, so that the maximum temperature is no longer found in Berar, but in the great dry region to the north-west. The lowest temperature occurs at Bombay, where the mean for the month is 82·7, while sea-level values exceeding 97° are found at many places in the Punjab and Rajputana.

The isotherm of 96° encloses Quetta, Kelat, Cabul and the greater part of the Punjab and Western Rajputana; while an outlying area includes Agra, Gwalior, Jhansi and Nowgong; being probably divided from the main region, by a relatively cool zone extending through Aligarh, Muttra, Bhurtpore, Deoli and Neemuch; though this is somewhat doubtful. In the centre of the hottest region, the stations Dera Ismail Khan, Dera Ghazi Khan and Mooltan have a slightly lower temperature, perhaps owing to the influence of the irrigation canals, which begin to fill towards the end of the month.

Along the inner ranges of the Himalaya, between Pithoragarh and the Sutlej valley, the temperature is higher than on the adjacent plains; while, at Murree, there are indications of the existence of similar conditions along the western part of the range. To the north of the Himalaya, the isotherms, in June, appear to run nearly north and south; Tibet being probably still a region of relative cold, while at Yarkand and Skardo the sea-level temperatures exceeds 92°.

July, Plate XVI.—In July, the lowest temperature occurs off the Bombay coast, where it probably does not exceed 80°; while, immediately behind the ghats, in Khandesh and the Deccan, it exceeds 84°; the rainfall in this part of the country being light. Over the whole of the Central Provinces, Berar and Malwa, in the region swept by the westerly winds, the temperature averages about 83°, at sea-level; though, in the valley of the Ganges and on the Chutia Nagpur plateau, where weaker easterly currents prevail, the temperature is about two degrees higher. The highest temperature in India occurs at Jacobabad, where it reaches 95° at sea-level. At Bahawalpur, Mooltan and Dera Ismail Khan it is little less.

Both in Afghanistan and Tibet, the sea-level value of the mean temperature probably reaches or exceeds 100°F., though of this we have no direct evidence, except in the observations made during two years at Gilgit, when these are taken alone.

At Kelat and Quetta, however, it almost reaches 99°, and at Yarkand it reaches 97·5°.

The isothermal lines of this month follow, very closely, the lines of equal rainfall, a rule which is especially obvious in the Himalaya; when each isotherm throws out a long loop to the north-west, enclosing a portion of the outer zone of the mountains and the plains below; the comparatively low temperature of the Bengal plains, being thus, as it were, carried forward by the south-easterly rainy winds which blow along the sub-montane belt.

August, Plate XVI.—The distribution of temperature, in this month, is very similar to that which obtains in July, though the Indus valley is several degrees cooler. The temperature now ranges from 80°, in the vicinity of Bombay, to 92° at Shahpur in the Panjab. The Vindhya range and East Berar are relatively cool areas, while Chutia Nagpur appears to be hotter than the surrounding districts. The cool belt of the Himalaya is apparently divided into two, in August, by the Sutlej valley; while the hot and dry character of the inner valleys of Kumaun is intensified in comparison with the rainy outer range.

September, Plate XVII.—In September, the isothermal lines are similar, on the whole, to those of July and August, though the temperature of the dry regions in the north and west is now much less. The lowest temperature still occurs off the Bombay coast, where it is below 80°; while, in north-west Rajputana and the Punjab, there is a long oval area above 90°, and to the west of Dera Ismail Khan among the Wazeeri highlands, the sea-level temperature probably also exceeds 90°.

The isotherm of 90° also includes considerable areas in the drier parts of the Himalayas; but, beyond the snowy range, the temperature now diminishes with an increase of latitude.

Among the abnormally hot regions, in this month, may be enumerated Khandesh, the Chhattisgarh plain and Chutia Nagpûr; while the Vindhyas, Northern Oudh and the Sub-Himalayan districts, as far west as Peshawar, are abnormally cool. This is also the case with the greater part of the Indus valley, where the effects of the inundation canals are now fully felt.

October, Plate XVII.—In October, the distribution of temperature, which is characteristic of the cold season, begins to be restored. Buldana is again one of the hottest places on our maps, and Peshawar is the coolest in India; the temperature of these being 84·1° and 75·3° respectively, at sea-level. Beyond the Himalaya, the temperature rapidly decreases, and is probably below 60° at Yarkand.

The isotherm of 84° surrounds several detached areas, the principal one being in Khandesh and the Deccan, another in Chutia Nagpur, and a third in the centre of Rajputana. The other isotherms follow rather irregular courses, more or less completely surrounding Central India. In Kumaun and at Murree are outlying maximum regions, the former of which has a sea-level temperature exceeding 80°, while the isotherm of 78° almost completely surrounds it. In Central Oudh, is another area, with a temperature above the average of surrounding districts. The isotherm of 80° makes a long bend to the south-west, to enclose Jubbulpore and Mandla, which have the same temperature as Chunar, much farther to the north-east.

November, Plate XVII.—In this month, the sea-level temperature varies from 79·1° at Buldana to 62·1° at Peshawar, 56·2° at Quetta, and 42·8° at Yarkand.

Off the Bombay coast and in the Gulf of Cambay, the temperature probably exceeds 78°.

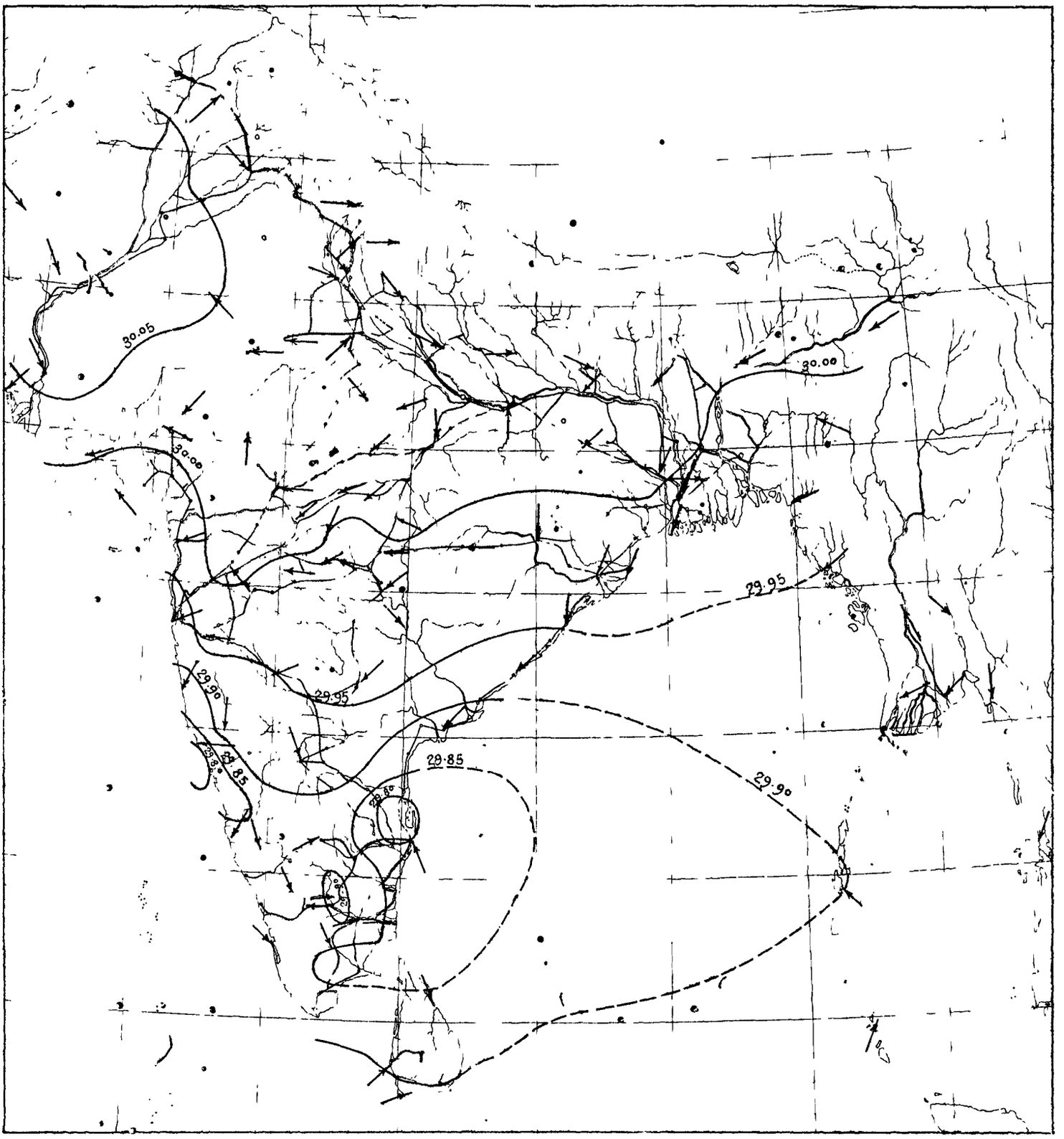
South-east Rajputana and Malwa are three or four degrees warmer than the Nerbada valley and Rewah; consequently, the isotherms of 76°, 74° and 72° push themselves far to the north-east in Rajputana, Central India and Bundlekand and then sweep back to the south-west in the Nerbada valley. The temperature of the Kumaun hills remains high, in comparison with that of the plains of Pilibhit and the Tarai, where fogs are of frequent occurrence in the forenoons.

December, Plate XVII.—In the last month of the year, which is usually almost as dry as November, the distribution of temperature resembles that of November more closely than it does the distribution which obtains in January; though the decrease with increase of latitude is more rapid than in November, and the temperatures, on the average, are several degrees lower. The highest temperature, 74·8°, is now found on the Bombay coast; while, at Peshawar, the sea-level value is 52·9°, the difference being thus 22°, or for

the same difference of latitude, nearly equal to that of January. At Quetta, the temperature is only 50°, and at Yarkand it is little over 30°F.

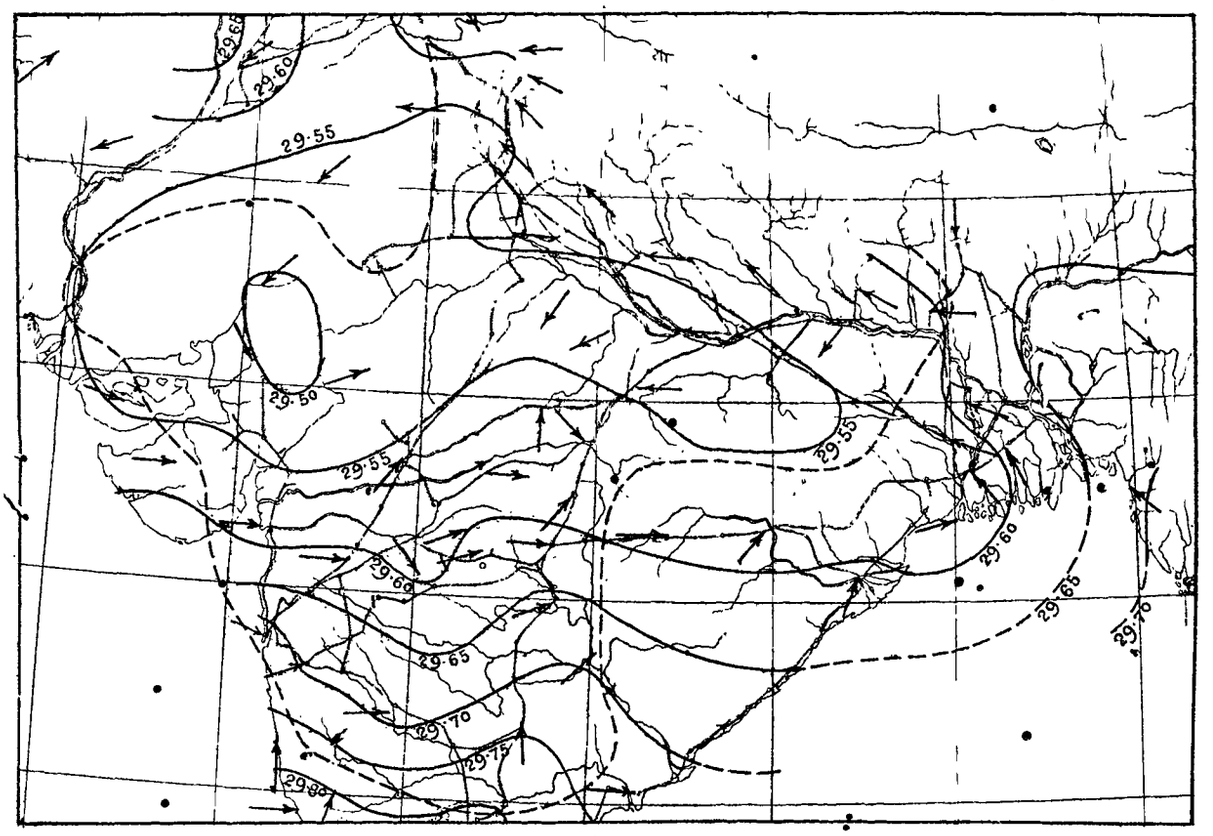
Malwa is still a relatively warm region, while the north-eastern part of the Central Provinces and Rewah are cool. The dry districts west of Delhi constitute a cold area, of which the centre lies near Sirsa. The lower districts of the North-Western Provinces are also cooler than the northern districts or the country south of the Ganges. In the Himalaya, where little snow falls until the end of the month, the inner ranges of Kumaun and Garhwal, the Kangra valley and the vicinity of Murree are warmer than the surrounding country.

Government of India Central Printing Office—No. 19, Meteor.—10-9-83.—400

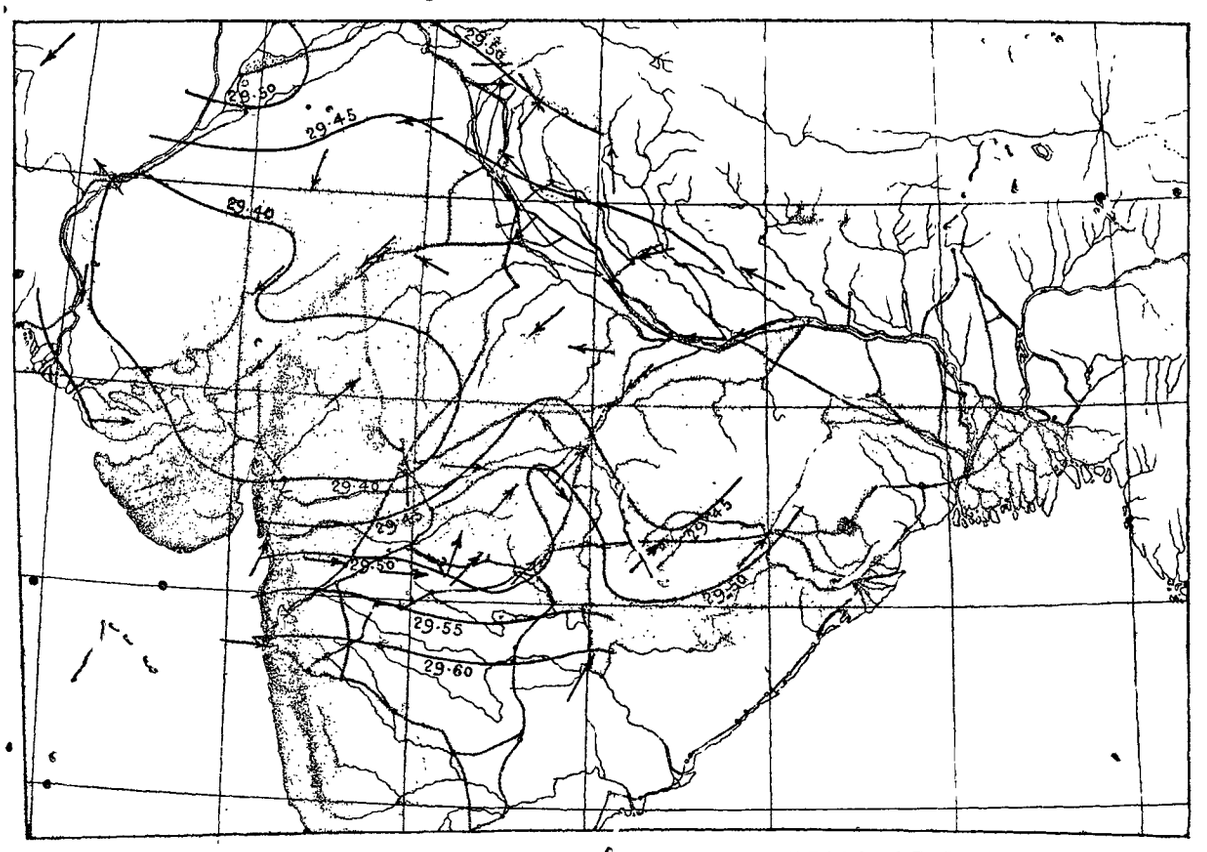


WIND AND PRESSURE AT 10 A.M.

Lithographed at the Survey of India Offices Calcutta September 1883

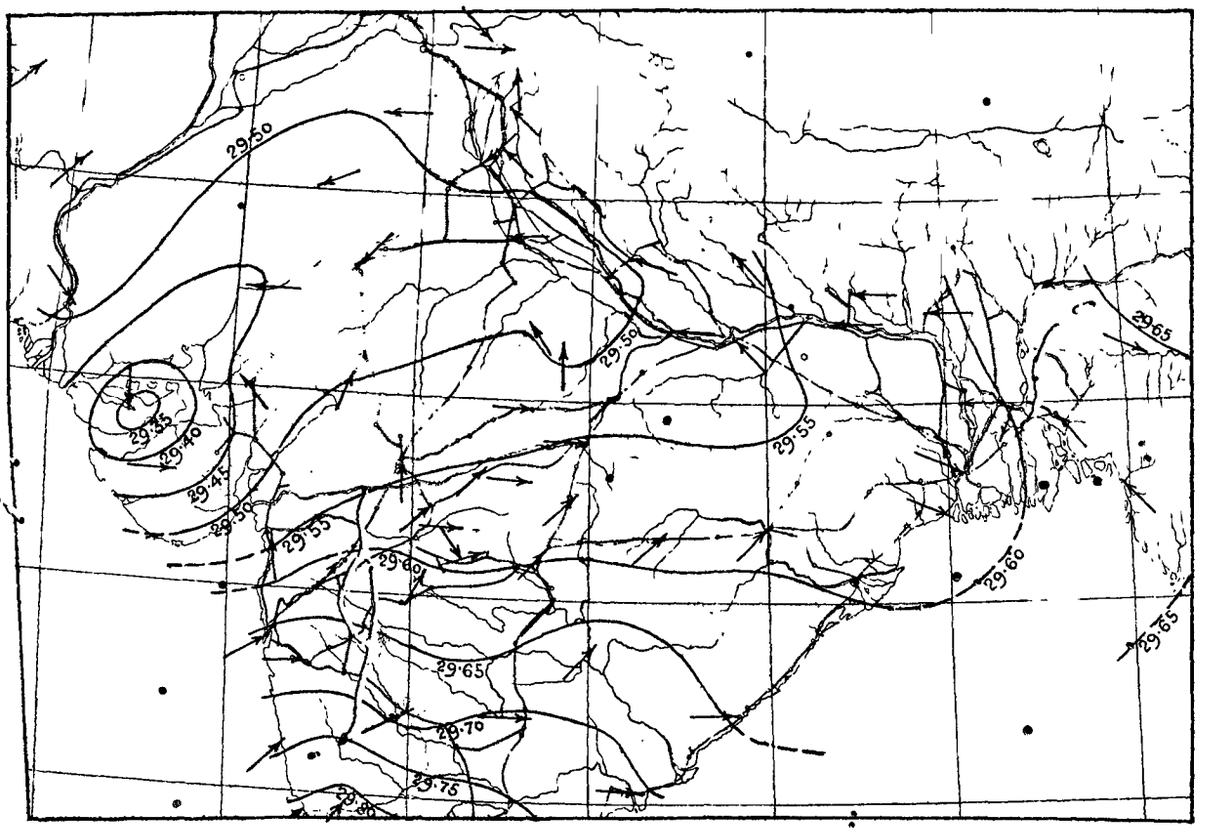


WIND AND PRESSURE AT 10 A.M.

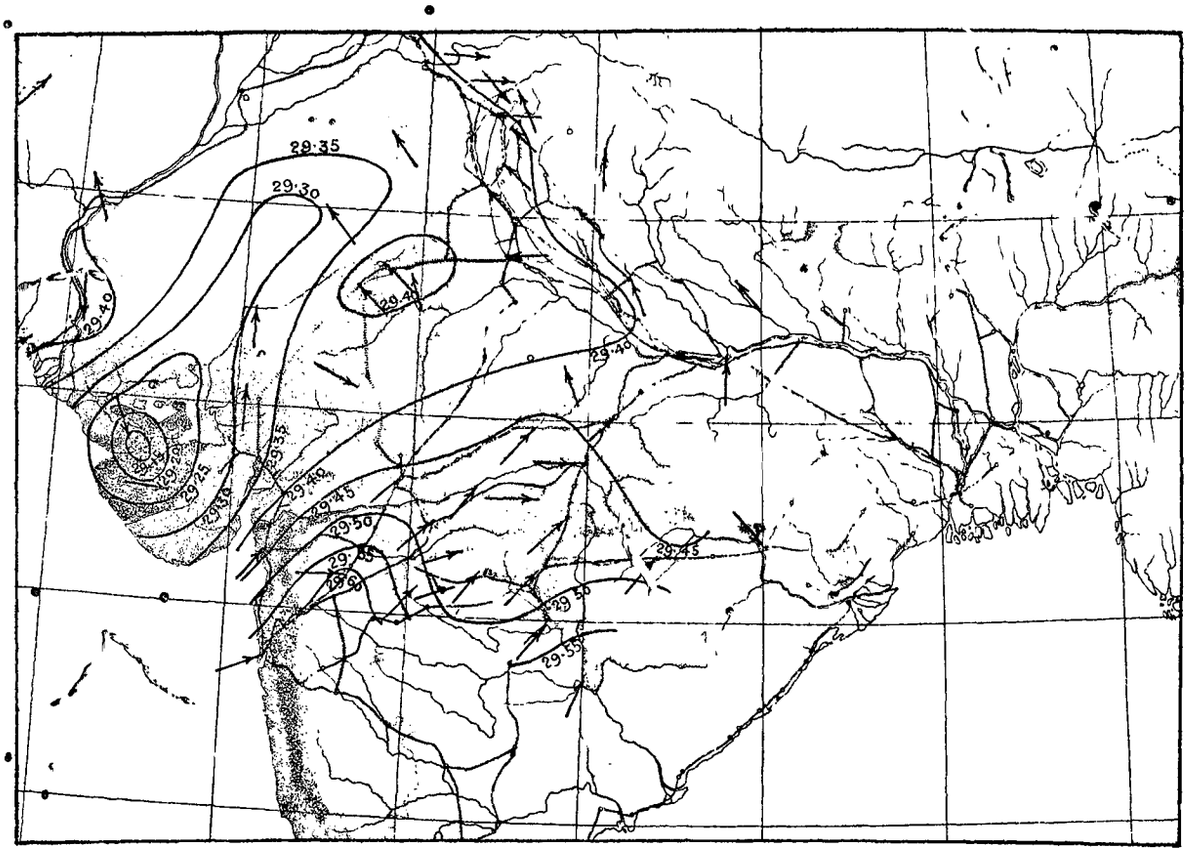


WIND AND PRESSURE AT 4 P.M. AND RAINFALL OF DAY.

Lithographed at the Survey of India Offices, Calcutta, October 1883

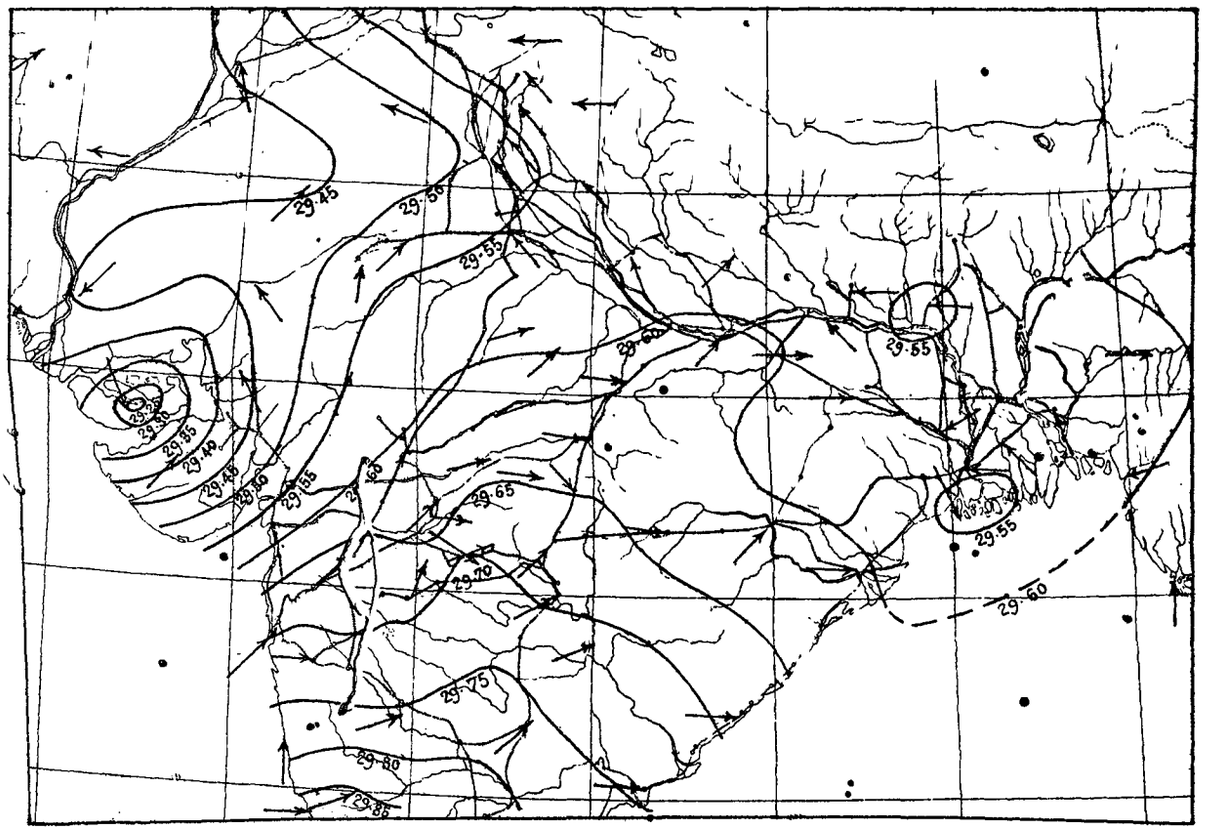


WIND AND PRESSURE AT 10 A.M.

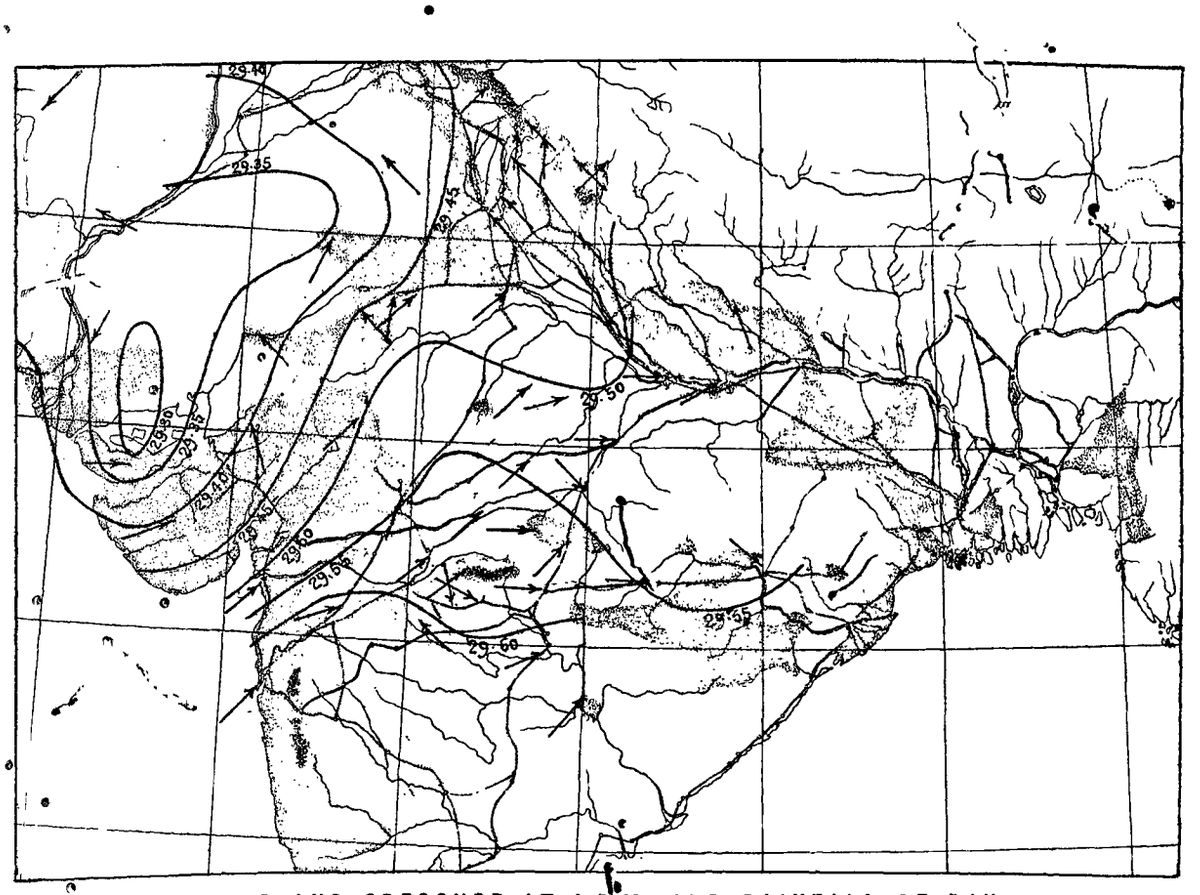


WIND AND PRESSURE AT 4 P.M. AND RAINFALL OF DAY.

Lithographed at the Survey of India Offices, Calcutta, November 1883.



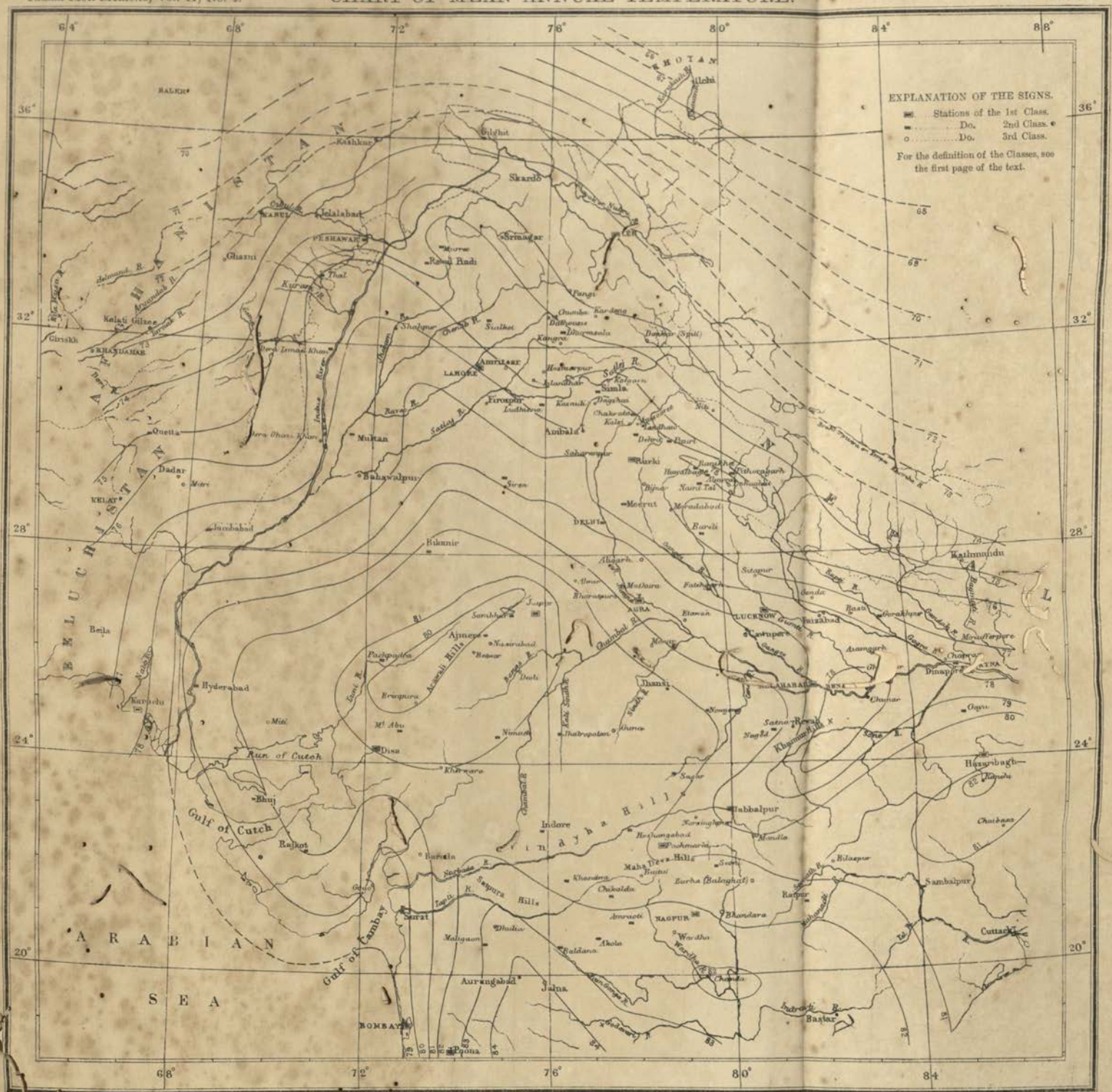
WIND AND PRESSURE AT 10 A.M.

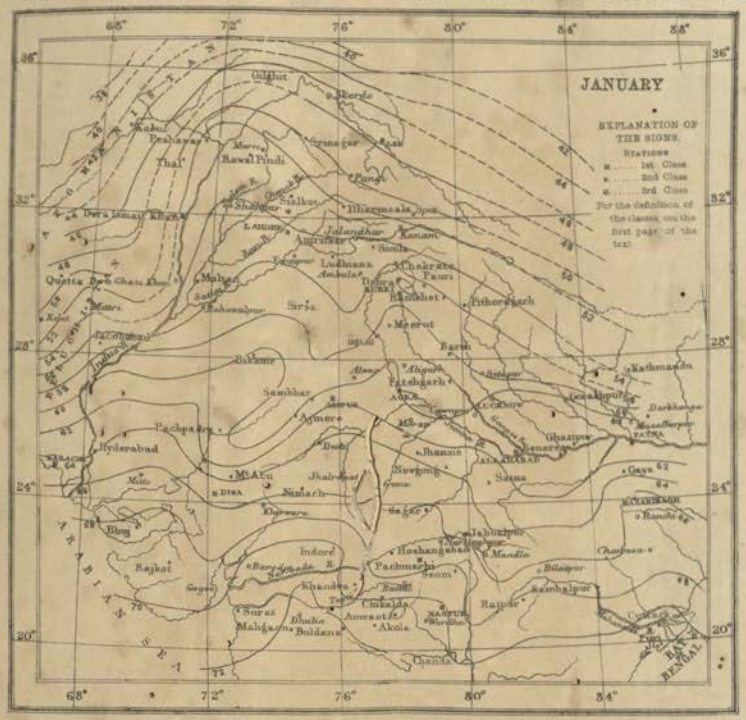


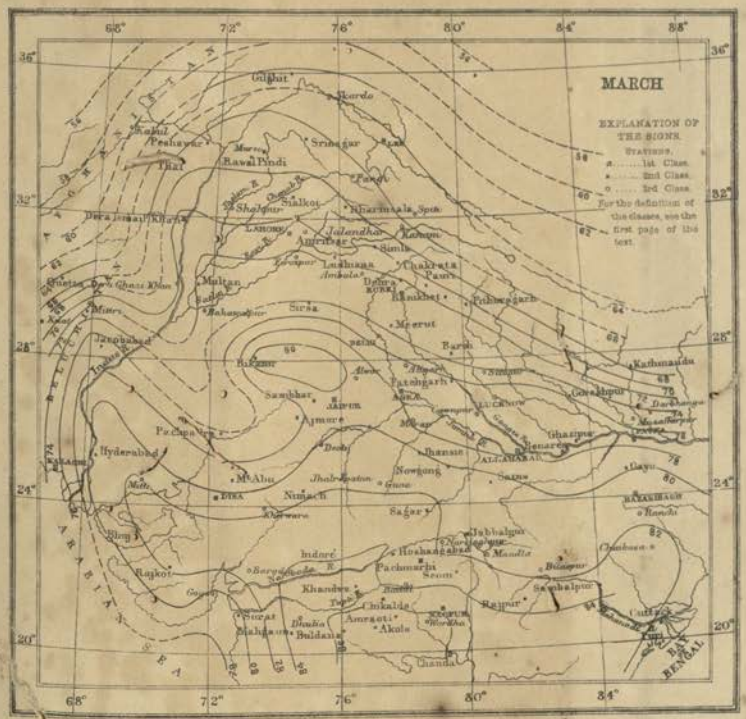
WIND AND PRESSURE AT 4 P.M. AND RAINFALL OF DAY.

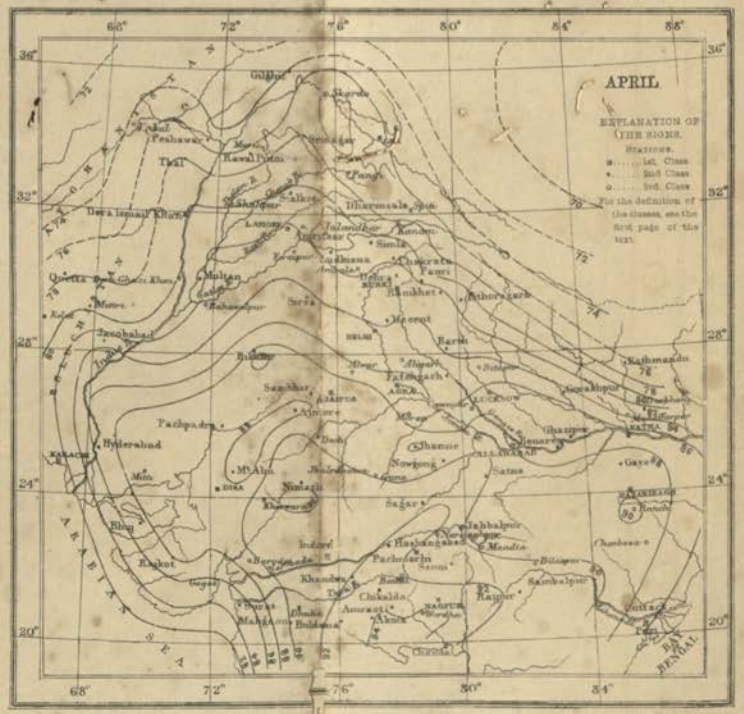
Lithographed at the Survey of India Offices, Calcutta, October 1882.

CHART OF MEAN ANNUAL TEMPERATURE.

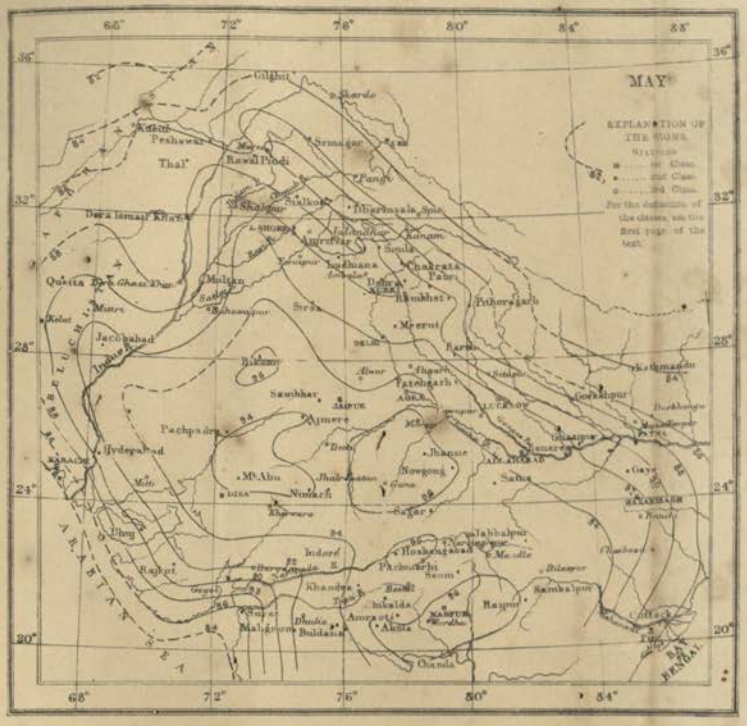

EXPLANATION OF THE SIGNS.
Stations of the 1st Class.
Do. 2nd Class.
Do. 3rd Class.
For the definition of the Classes, see the first page of the text.
64°
68°
72°
76°
80°
84°
88°
36°
32°
28°
24°
20°
BALKH
KABUL
Jelalabad
PESHAWAR
Ghazni
Kelati Ghilzai
Girishk
SHIKARPUR
Quetta
Dadar
KELAT
Jacobabad
Bahawalpur
Multan
Dera Ismail Khan
Dera Ghazi Khan
Sukkur
Jacobabad
Bikanir
Beila
Hyderabad
Karachi
Mir
Mt. Abu
Run of Cutch
Gulf of Cutch
Bhuj
Rajkot
Diisa
Khararo
Gulf of Cambay
ARABIAN SEA
BOMBAY
Poona
Surat
Malgaon
Dhulia
Aurungabad
Jalna
Baldana
Akola
Amraoti
NAGPUR
Wardha
Chanda
Bhandara
Raipur
Sambalpur
Cuttack
Baster
Indore
Barcela
Kharagon
Chikalda
Maha Deo Hills
Satpura Hills
Vindhya Hills
Jubbalpur
Mandla
Hoshangabad
Hosheria
Sohagpur
Nagpur
Khamgaon
Ajmere
Nasirabad
Pushpawtia
Kherwara
Aravalli Hills
Deoli
Erinpura
Nimach
Dhabropatan
Kharia
Jeypur
Sambhar
Jaipur
Bharatpur
Dholpur
Agra
Mathura
Etawah
Furrukhabad
Shahjahanpur
Cawnpore
LUCKNOW
Fatehpur
Allahabad
Dhamri
Singrauli
Satna
Rewah
Nagod
Khamgaon
Hazaribagh
Ranchi
Chaibasa
Sambalpur
Cuttack
Baster
Indrawati R.
Godavery R.
Wurdha R.
Chanda
Kaithmandu
Darjeeling
Purnea
Monghyr
Chapra
PATNA
Dinapore
Ghazipur
Benares
Jaunpur
Allahabad







Lithographed at the Survey of India Offices, Calcutta, September 1883.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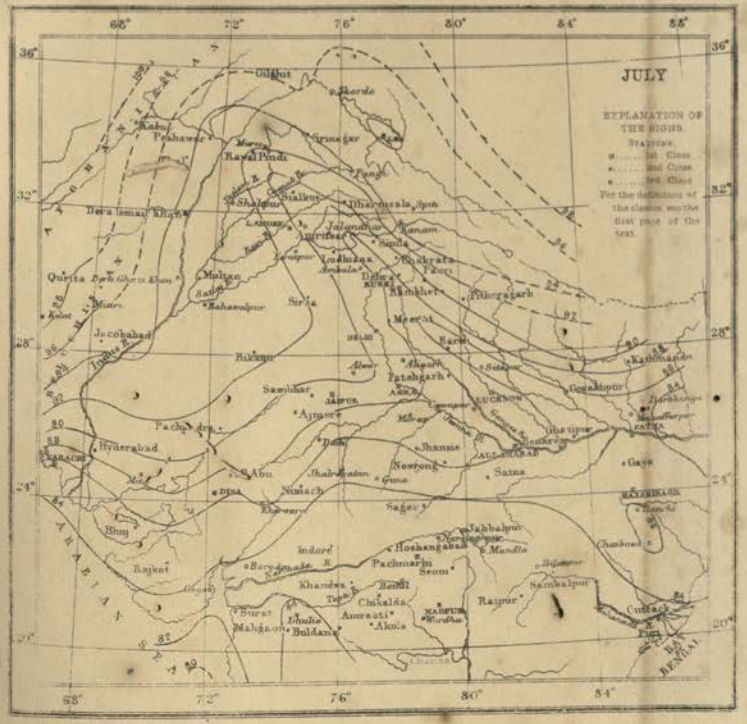
EXPLANATION OF THE SIGNS.
Stations.
1st Class.
2nd Class.
3rd Class.
For the definition of the classes, see the first page of the text.

JUNE
EXPLANATION OF THE SIGNS.
Stations.
1st Class.
2nd Class.
3rd Class.
For the definition of the classes, see the first page of the text.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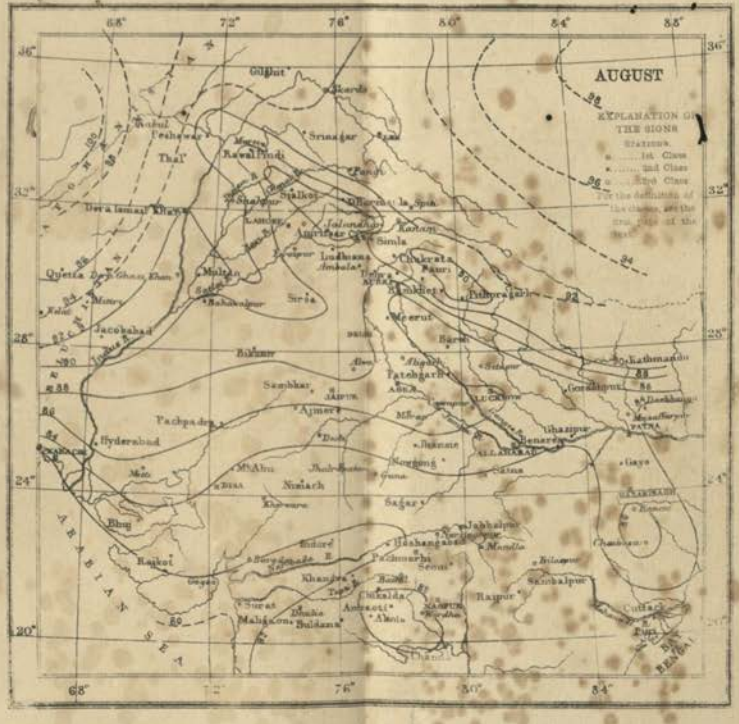
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Stations.
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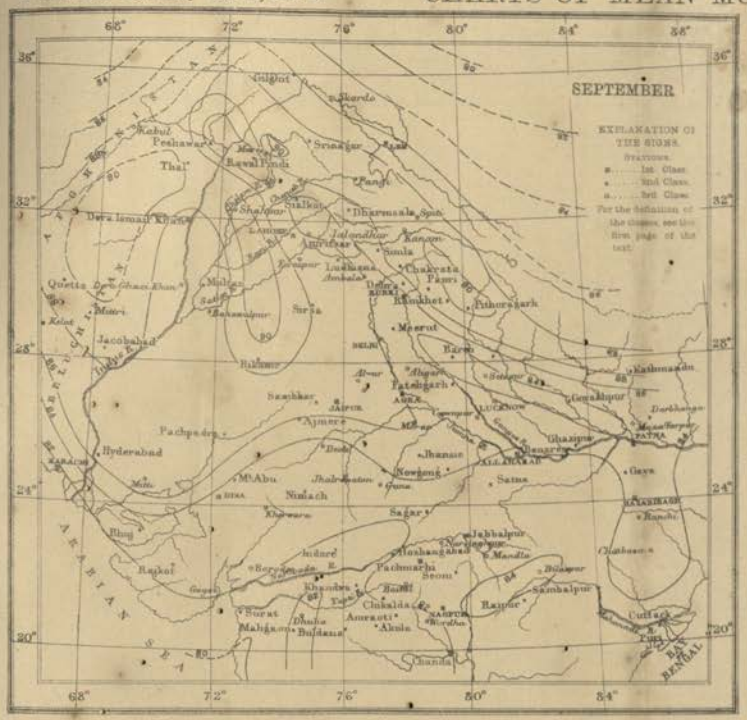
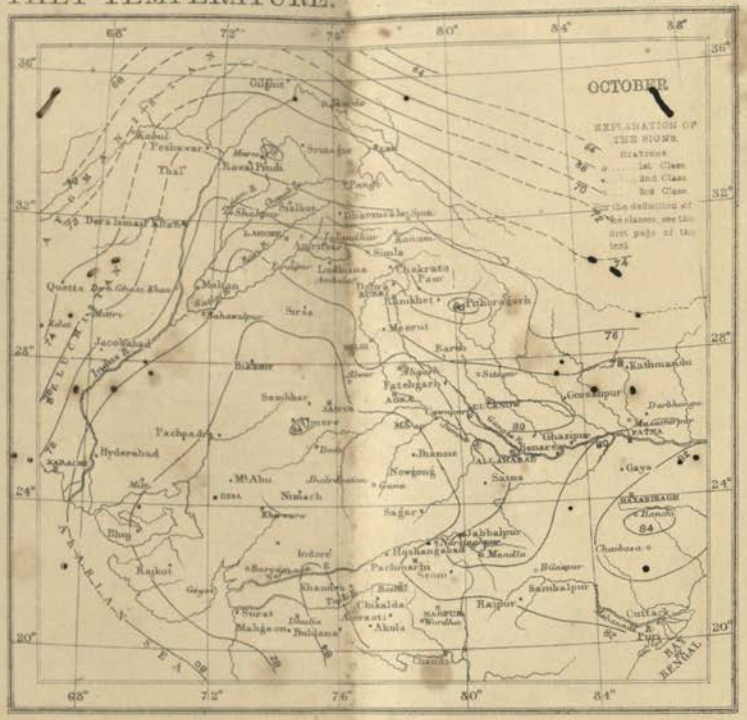
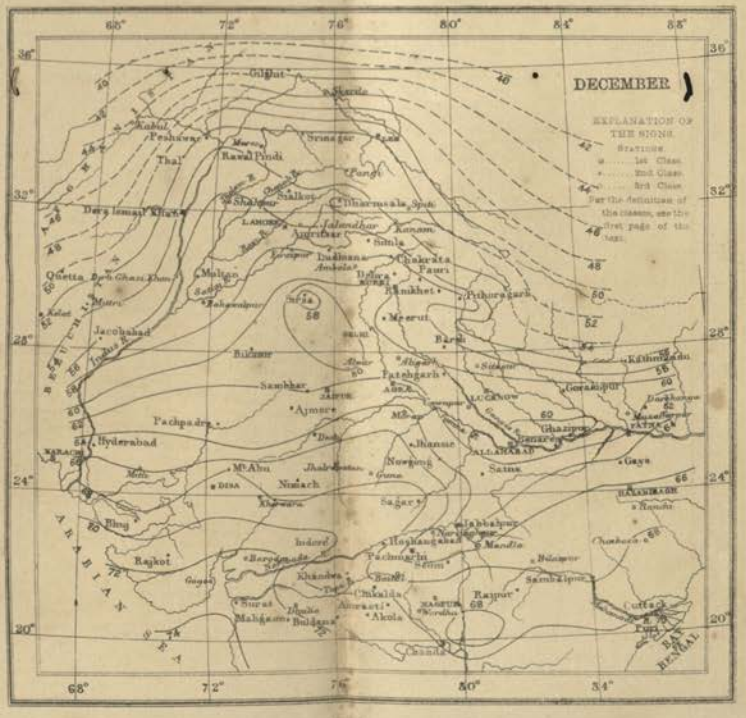
For the definition of the classes, see the first page of the text.







Lithographed at the Survey of India Offices, Calcutta, September 1883.

ABSOLUTE ANNUAL RANGE OF TEMPERATURE.

Lithographed at the Survey of India Offices, Calcutta, September 1893.

V.—Account of the South-West Monsoon Storm of the 8th to the 19th of October 1882 in the Bay of Bengal, by JOHN ELIOT, Esq., M.A., *Meteorological Reporter to the Government of Bengal.*

CHAPTER I.

INTRODUCTORY.

THE Bay of Bengal has been free from the most severe form of cyclone since the Backergunge cyclone of 1876. During the prevalence of the south-west monsoon, a succession of storms are generated in it and advance landwards, disappearing after giving more or less heavy rain over well-defined tracts of the country. These storms are a recurrent and well-marked feature of the rains. They were formerly known as westerly gales amongst seamen, as their chief feature is the very strong westerly and south-westerly winds on the eastern and southern quadrants which accompany them. They are, however, now known to present all the features of atmospheric cyclonic motion on the large scale, and only differ from the most severe cyclones in the smallness of the barometric depressions which accompany them, and in the absence of a dangerous storm-wave.

The following is the list of these storms which occurred during the year 1882 :—

(1) Storm of June 8th to the 17th, formed near the head of the Bay and advanced across the Orissa coast into the Central Provinces and eastern districts of the North-Western Provinces.

(2) Storm of July 16th to the 23rd, formed about lat. 17° N. and long. 85° E., advanced northwards to the mouth of the Hooghly, recurved and moved west-north-west across the head of the Peninsula into Rajputana.

(3) Storm of September 5th to the 14th, formed off the coast of Orissa and advanced in a curved north-west path across the Orissa coast to Rajputana.

(4) Storm of September 14th to 19th, formed in nearly the same part of the Bay as storm No. 2. It moved almost due north across the Orissa coast into North Behar.

(5) Storm of September 26th to 3rd October, formed off the Burmah coast and advanced across the Orissa coast into the North-Western Provinces.

(6) Storm of October 12th to 17th, formed near the coast of the Circars, crossed the Ganjam coast, and advanced north-north-east into Northern Bengal.

(7) Storm of November 23rd to 27th, formed to the east of Negapatam and advanced north-west, crossing the coast midway between Madras and Negapatam, and passing across the Peninsula to Ratnagiri.

Of these, the most remarkable, on the whole, was the sixth storm in the list, which originated in the centre of the Bay, advanced in a north direction across the Ganjam and Orissa coasts, and then recurved, running nearly parallel to the coast in a generally north-easterly direction into Central Bengal, where it finally broke up and disappeared. Among its more remarkable features were the widely diffused and heavy rainfall which accompanied it, the smallness of the barometric depression, and the apparent absence of any well-defined centre. The present paper gives the meteorological information

collected by the Bengal Meteorological Office, a brief history of the storm, and a discussion of its more salient features.

A storm may be briefly defined as a violent and extensive atmospheric disturbance. In the great majority of cases in India, if not in all, the motion is of a peculiar character, called cyclonic or vorticose. The air in the lower atmospheric strata is drawn inwards from all directions towards a central area, over which the air moves spirally upwards to some considerable height, and thence it flows outwards in a manner probably approximately the reverse of the lower motion of indraught. This is by no means a complete or satisfactory method of considering the totality of the phenomena which constitute a storm. During the existence of a cyclone, a vast amount of motion or kinetic energy is given to a large mass of air. This rapid accumulation of motion is usually the work of a few days, and it disappears again with equal rapidity. There is therefore a rapid conversion of some pre-existing form of energy into the kinetic energy of the atmosphere. A complete discussion of any known transformation of energy implies the consideration of two distinct questions—

1st.—The source and character of the energy which admits of transformation.

2nd.—The conditions under which the transformation is effected.

A storm therefore implies that, during its existence, some pre-existing form of energy is being rapidly converted into the kinetic energy of the moving mass of air, and this conversion can only take place under certain conditions. Various theories have been devised to account for the formation of cyclones, in the majority of which, some one condition has been treated as if it were the sole or the effective cause. The phenomena of the present as of many previous storms or cyclones in the Bay of Bengal appear to me to indicate that it is the energy or heat given out by the condensation of aqueous vapour which is transformed into the kinetic energy of the air, and that the one important and effective condition for this transformation is more or less prolonged and concentrated rainfall over a definite area. This is only possible under certain antecedent conditions in the Bay of Bengal. Among the favourable circumstances (which therefore constitute indications of the probable early occurrence of a cyclone) in the meteorology of the Bay of Bengal appear to be the following, as they have been found to be present immediately before and during the generation of every storm, the history of which has been traced out by either Mr. Blanford or myself:—

1st.—Uniformity of pressure over the greater part of the Bay, and the adjacent districts of Bengal, Orissa, &c., and usually over the whole of Northern India.

2nd.—Almost entire absence of rainfall over North-Eastern India, and the coasts of the Bay (more especially the northern coast).

3rd.—The prevalence of fine clear weather, with light and variable winds in Bengal and Orissa, and, in the case of the more severe cyclones, over the whole of Northern India.

4th.—The prevalence of a strong southerly air current, laden with aqueous vapour, over the entrance and south of the Bay.

5th.—Certain critical circumstances connected with aqueous vapour condensation, the conditions of which are not fully known, but which determine the commencement and continuance of rainfall over a limited but well-defined area, and over which the rainfall becomes more and more concentrated.

This theory when properly stated is known as the condensation theory. It has been employed, in slightly modified forms, by several American and European meteorologists, as, for example, Ephy and Reye, to explain cyclonic formation and motion generally.

A reference to such a work as Taylor's Sailing Directory, or to the publications of the India and Bengal Meteorological offices, will show that there are at least two different kinds of atmospheric disturbances which affect the Bay of Bengal. One class originate over the land and pass seawards. They are similar in their features to the storms known as "nor'-westers" in Bengal, and "dust-storms" in Upper India. The barometer gives little or no warning of their approach. The first intimation is usually the appearance of a small cloud on the horizon. This cloud slowly increases for some time, whilst the air is almost, if not quite, still. A sudden burst of air ushers in the storm. The wind veers round the compass, and blows sometimes in excessively violent gusts. Thunder, lightning, heavy rain generally, and sometimes hail, accompany the storm. They usually occur during the hot weather months of March, April, and May, and are apparently due to the direct action of the solar heat, and to rapidly increasing temperature. Even if they occur at sea, as they occasionally do in the north of the Bay, they are the continuation of storms over the land. These land-generated storms, although they are characterised by violent cyclonic air motion, and advance in a definite direction along a clearly-marked path, are very short lived. From nine to twelve hours is probably the utmost duration of their existence.

The second and more important class of storms originate in the Bay of Bengal and travel landwards. They are of very much greater extent. Although they do not always give rise to stronger winds than the previous class of storms, the violent air motion is spread over a much greater area, and perhaps extends to a greater height, and lasts for a much longer period. They vary very greatly in magnitude, from the small cyclones or south-west monsoon storms of the rains, with a depression seldom exceeding ·3″, to the rare, but extensive and dangerous cyclones of the transition periods, in which the barometric depression may be 2·5 inches, and the storm-wave may destroy the greater part of the shipping of a port like Calcutta, or submerge a large low-lying district like Backergunge.

It should be carefully remembered that these storms are generated over the sea and travel landwards. They do not differ from the former in the intensity of the wind gusts and squalls, but in the extent and duration of the cyclonic motion. They occur only during the months when the south-west monsoon is in possession of a part, or of the whole, of the Bay. The south-west monsoon usually commences over the south of the Bay in the third or fourth week of May, but sometimes considerably earlier, whilst it does not finally retreat from it until the middle or end of December. Hence storms may occur in connection with it, at any time between the beginning of May and the end of December, and, under very exceptional circumstances of the duration of the south-west monsoon, even beyond these limits. These cyclonic storms appear to be essentially a feature of the south-west monsoon, and therefore dependent on it, in some way, for their generation. Hence I propose to call them south-west monsoon storms.

It is generally admitted that meteorological changes and disturbances are due primarily to the solar radiation. The energy of the sun's heat, or the solar radiation, is converted into the potential energy of pressure, or the kinetic energy of winds,

or into the molecular energy of change of state or condition; (that is, the latent heat energy of the aqueous vapour contained in the atmosphere).

The solar radiation, hence, increases the energy of the atmosphere in various ways, *viz.*:—

1st.—Directly, as, for example, by heating it, *i.e.*, increasing the temperature or molecular motion of its mass.

2nd.—Indirectly, by converting water into aqueous vapour, which mixes with the air, and thus increases the total energy of the gaseous mixture.

In the former case, the conversion of the potential energy of pressure, or of heat, into the kinetic energy of air motion, goes on usually more or less continuously, and it is only occasionally that the potential energy appears to accumulate for some time. Then there is a more or less sudden conversion into kinetic energy, giving rise to the brief and short-lived storms of the hot weather.

In the other case, when rainfall occurs, the energy expended or heat transformed during evaporation is given back, and converted into some other form of energy. It is not changed into heat given to the rain-drops themselves, to any considerable extent, and hence must be given up to the atmosphere from which the rain descends. The most important point in connection with this is the rate at which this energy may be given up to the atmosphere, as compared with the rate at which energy is imparted by the direct action of the sun. This will be determined with sufficient exactness, by comparing the direct evaporating power of the sun with the rate at which condensation may take place. The best experiments[1] appear to prove that the sun on a cloudless day produces very little change of temperature in the air over the Bay of Bengal, and that its energy is probably not sufficient to evaporate more than one-tenth of an inch of water. We shall, however, assume that the evaporation of half an inch of sea-water may be taken as an estimate of the direct action of the sun, and of the absorption of energy by the atmosphere due to this action. On the other hand, rainfall occurs occasionally over the land in India, and very probably over the sea during storms, at the rate of 10 to 20 inches per diem, for periods of 24 hours and upwards. We may take 10 inches as by no means an excessive estimate of the amount of rainfall in tropical storms over a considerable extent of the sea in one day. During such rainfall, 20 times as much aqueous vapour is converted into rain in 24 hours over a given area of sea surface, as the sun can re-convert into aqueous vapour in one day over an equal area.

In other words, the disturbing effect or the rate of absorption of energy by the atmosphere, during rainfall, may be as much as 20 to 30 or even 40 times as great as the increase or absorption of energy due to the direct action of the sun. Hence the probability, if not certainty, that storms due to rainfall may be much larger and more intense and prolonged than storms caused by the direct heating action of the sun, or by relative differences of pressure and temperature.

The rapid rate at which the potential energy of aqueous vapour is converted into heat and the kinetic energy of the atmosphere, more especially in tropical storms, is a point which appears to demand the fullest consideration and recognition.

Again, in consequence of the uniformity of the water surface of the Bay of Bengal, and the utilisation of the greater portion of the solar heat in the work of evaporation, it is *à priori* certain that storms due to the direct disturbing action of the sun—that

[1] *Vide* Cunningham's Roorkee Hydraulic Experiments, Vol. I, pp, 383-4.

is, merely to differences of pressure and temperature over it—will rarely, if ever, occur. They may originate where the solar action in producing changes of temperature is considerable,—that is, over the land,—and travel towards the Bay, but not *vice versâ*. As a matter of fact, such storms as nor'-westers have, so far as I am aware, never been observed to originate in the Bay itself.

On the other hand, the phenomenon of rapid and continuous evaporation is essentially a characteristic of the Bay and of the Indian Ocean. Heavy concentrated rainfall is equally a feature of the Bay and of India itself during the south-west monsoon. The conditions required for originating a storm are, however, much more frequently present at sea than over the land. Hence storms due to rainfall are a common meteorological feature of the Bay during the south-west monsoon. They originate in the Bay and travel landwards. Occasionally, however, the cyclonic motion may accompany heavy rainfall over the land, and in that case, in all the instances which have come across my observation, the storm is either stationary, or moves further inland.

A storm is an atmospheric disturbance due to some central condition, as, for example, a barometric depression (according to one class of meteorologists), or to some localized and central action, as, for instance, heavy rainfall over a small and definite area (according to a second class of meteorologists). Whatever the central condition or action may be, it is certain that it gives rise to the peculiar atmospheric motion known as cyclonic motion. If the area of the central state, or disturbance, were surrounded by an area of identical atmospheric conditions in all directions, it might be difficult to predicate what the motion would be. Such an equality of conditions, however, never exists. In virtue of the inequality of conditions, the inrush assumes the nature of whirling, vorticose, or cyclonic motion. When the whirl is exceedingly small, the rotatory motion may be either right handed or left handed, as in the case of the small dust-whirls, known as "devils," in Upper India. On the other hand, when the inrush is extensive, the chief inequality in different directions is not differences of pressure or temperature, but differences of rotational velocity round the earth's axis. Hence the strength and character of an atmospheric whirl on the large scale appears to depend upon two different elements or conditions only:—

1st.—The intensity of the central disturbance, which (according to the condensation theory) is the rate of vapour condensation, or of rainfall. This is usually much greater in tropical regions than in temperate, and may in the former be excessive as compared with the latter.

2nd.—The rate of change of the rotational velocity at the earth's surface in different latitudes. The rate of change is proportional to the sine of the latitude, and hence is zero at the equator, and is nearly three times as great at latitude 45° (as, for example, in the Central North Atlantic) as it is in latitude 15°, as in the centre of the Bay of Bengal.

The same central disturbance will thus give rise to a much stronger atmospheric whirl or cyclonic storm in the Atlantic than in the Bay of Bengal. On the other hand, as the heaviest rainfall in the Bay of Bengal is perhaps five to ten times greater in amount, and is also more prolonged than that in the Atlantic, it is evidently theoretically possible, that storms may occasionally occur in the Bay of Bengal of much greater intensity and extent, than any in the temperate parts of the Atlantic ocean.

The determination of the probable path of a cyclone from the antecedent condi-

tions is a problem of the greatest possible interest in cyclone motion. No successful attempt based on the condensation theory, so far as I am aware, has been made in the case of the cyclonic storms of the North Atlantic ocean, which advance across the shores of West Europe into the interior of Europe. The conditions accompanying the production of the larger cyclones of the transition periods and of the rains differ considerably, and it would hardly be expected that the paths of cyclonic vortices should be indicated by the same antecedent factors in the two cases.

There is one very striking difference between the extensive cyclones of May and October and the smaller cyclones of the rains. The former, notwithstanding the greater extent and intensity of the disturbance, are much shorter lived, and hills of moderate elevation appear to prove an effective and insuperable barrier to their progress. In many cases, as in that of the Vizagapatam cyclone of 1876, the hills cause them to recurve, and advance in directions nearly at right angles to their former paths; whilst in others, as the Backergunge cyclone, they break them up in the space of a few hours. There is not as yet a single authenticated case of any large cyclone of the transition periods crossing the Eastern Ghats or the Orissa hills, or even the Chutia Nagpore table-land, into the interior of Central India. On the other hand, the same hills, which prove so effective a barrier to the larger cyclones, have hardly any effect on the smaller ones. There are several cases on record during the period 1877-83, of the smaller storms of the rains crossing over the Orissa hills and the Eastern Ghats, acquiring increased energy and vitality, marching slowly across the head of the Peninsula, and finally breaking up, after a prolonged existence on land of five or six days, in the Bombay Presidency, Guzerat, or Cutch, in the immediate neighbourhood of the Arabian Sea. The storm, for example, of the last week of June 1883 at the head of the Bay crossed the Balasore coast on the morning of the 29th June, drifted slowly across the head of the Peninsula, gave very heavy rain over its path, more especially in the valley of the Tapti, and finally passed from Guzerat into the Arabian Sea on the evening of the 3rd or morning of the 4th July.

Such a difference in the vitality of the two classes of cyclonic storms of the Bay is evidently of great importance, and can only be due to some marked difference in their formation, or character. There is only one feature in which it appears to me that they may differ, which will explain these facts.

The chief and effective cause of cyclones is the rapid condensation of aqueous vapour over a limited central area. It is evident that the condensation and its accompanying transfer of energy to the atmosphere may occur at different levels, according to the varying meteorological conditions. Thus, at the transition periods, when the accumulation of vapour is largely due to local evaporation, and hence takes place mainly in the lower atmospheric strata, it is probable, if not almost certain, that the condensation will occur at a comparatively low level, and hence the cyclonic motion of indraught below and outdraught above will only extend to a moderate elevation, and the whole cyclonic circulation will be confined within limits from the sea-level upwards, not much greater than the elevation of the hills of Eastern Bengal, Orissa, &c. If this be the case, these hills will form a complete and effective barrier to the progress of such a cyclonic motion.

On the other hand, during the rains, aqueous vapour condensation is mainly due to slight initial changes in an atmosphere, almost saturated up to very considerable heights.

Hence, it is probable, not only that the condensation will in this case occur at a much greater elevation than in the preceding, but that it may extend through a greater vertical depth of atmosphere, and the whole motion through a much greater height, and the main body of the indraught, instead of occurring near the earth's surface, may in consequence take place at a considerable height above it. Cyclonic motion extending to a height of 10,000 feet for example, and in which the aqueous vapour condensation occurs at an elevation exceeding 5,000 feet, may be accompanied by, and give rise to, comparatively feeble motion near the earth's surface, and may advance almost unaffected, and certainly unbroken, over hills 2,000 and 3,000 feet high, such as the Orissa hills or the Eastern Ghats. No further consideration appears to be necessary to show that the different phenomena may be explained by the assumption of cyclones of low elevation, and cyclones of high elevation. The one class, of course, pass into the other by insensible gradations. There are, however, clearly-marked differences between the two types of cyclones which originate in the Bay of Bengal, in connection with the south-west monsoon.

It is hence very probable that the circumstances which determine the path of one, will not be exactly the same as in the other.

In the case of cyclones of the transition periods, an examination of those of recent occurrence seems to show that they advance in the direction of relative least air motion, immediately prior to the generation and motion of the vortex. The smaller cyclones of the rains, which occasionally traverse the whole breadth of India, have not yet been sufficiently investigated to indicate the antecedent circumstances which probably determine their paths. There is, however, one meteorological feature during the rains, of the tract of country stretching from Orissa to Cutch, Guzerat, and Sind, which has apparently an important bearing on the motion.

The greater part of this belt, or tract of country, is an area of unsteady and variable winds during the south-west monsoon, when compared with the larger districts to the north and south. The cause of this is evident. To the north of it, the Bay of Bengal branch of the monsoon current prevails and gives fairly steady winds, and to the south, the winds are due to the Bombay branch of the monsoon current. In the intermediate region there is much variable and irregular action accompanying their intermingling. The area, over which the interaction occurs, varies with the relative strengths of the two branches of the monsoon current. The meteorological features of this intermediate area, during the south-west monsoon, are lightness, irregularity, and variability of the winds, as compared with the regions to the north and south. Experience appears to indicate a strong and marked tendency in the cyclones of the south-west monsoon period proper—*i.e.*, when the south-west monsoon is established over the Bay of Bengal and Arabian Sea—to advance over this area. The evidence for this will be given in a succeeding paper.

CHAPTER II.

History of the Cyclonic or South-West Monsoon Storm of October 1882.

The history of this cyclone dates from the 7th of October. For several days preceding the storm, there had been little or no rain in Upper India, and only light showers in Bengal. The rainfall in Bengal and Behar also ceased on the 6th, and no rain occurred for some days. At that time, the easterly monsoon current up the Gangetic valley had

gradually retreated eastwards down the valley. In Upper India, the cold weather westerly winds were being established, whilst in Behar and Bengal, light and variable winds were prevalent. The Bombay branch of the monsoon current had died away, and hence, over nearly the whole of India, there were either light unsteady gentle winds, or calms. Over the south of the Bay, the south-west monsoon continued to blow with considerable force, and brought up supplies of vapour, which were no longer carried into Bengal and the Gangetic valley.

The most important feature of the meteorology of the 7th of October was the remarkable uniformity of pressure over the Bay, and the greater part of India. Pressure was very slightly in excess along the eastern coast of the Bay, as compared with the western coast, but the differences were very small, and were only equivalent to a pressure of about one-tenth of an ounce per square inch, acting over a distance of nearly 800 miles. The following figures illustrate the uniformity of pressure on each coast, and the very small differences between the pressure on the opposite coasts of the Bay:—

East of the Bay.		West of the Bay.	
Stations.	Barometer 10 A.M. reduced to sea-level.	Stations.	Barometer 10 A.M. reduced to sea-level.
Nancowry	29·899	Negapatam	29·883
Port Blair	·900	Madras	·880
Diamond Island	·920	Vizagapatam	·886
Akyab	·911	Gopalpore	·884
Chittagong	·903	Saugor Island	·880

These observations also show that the pressure was very slightly greater on the Ganjam and Arakan coasts, and therefore very probably over the connecting part of the Bay, or over the area in which the cyclone was afterwards generated.

The exceedingly small differences of pressure over the whole of Northern India is shown by the following observations taken at the more important stations, and which are known to be thoroughly trustworthy:—

Stations.	Barometer 10 A.M. reduced to sea-level.	Stations.	Barometer 10 A.M. reduced to sea-level.
Calcutta	29·879	Allahabad	29·869
Berhampore	·885	Lucknow	·869
Burdwan	·879	Roorkee	·879
Hazaribagh	·884	Lahore	·866
Patna	·901	Mooltan	·864

The atmospheric circulation affords equally strong evidence of the general meteorological conditions of the Empire. Calms were recorded at a large number of stations

from the Punjab eastwards as far as Bengal. The wind directions at the remaining stations indicate no general circulation. At adjacent stations, light airs from opposite directions were recorded. In a word, light, variable, and irregular winds, local in character, prevailed over the whole of Northern and Central India.

The meteorological information, extracted from the logs of vessels traversing the Bay at this time, are not sufficient to give complete and satisfactory information of the weather over the whole of the Bay. They are, however, sufficient in number to indicate, with approximate precision, the atmospheric conditions.

Vessels.	October 7th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Erin's Gem	9-30 A.M.	...	...	...	...	29·020	...	29·070	S.	...	Commence light winds from south. Fine weather. Wind south during the latter part of the day. Midnight.—Moderate wind or calm, and cloudy.
	Noon	0° 27′ S.	...	75° 30 E.	...	·840	...	·890	S.	...	
Kerbela	5-47 A.M.	12° 00′ N.	...	...	...	30·140	79	29·884	N. N. W.	1	A. M.—Wind light from north-north-west. Fine clear weather. P. M.—Weather overcast, calm, with smooth sea. Midnight.—Calm and overcast, with lightning all round.
	8 A.M.	...	...	...	...	·180	79	·924	...	...	
	Noon	11° 7′ N.	11° 9′ N.	75° 28′ E.	75° 32′ E.	·180	80	·922	...	1	
	4 P.M.	...	...	...	...	·140	82	·877	...	...	
	8 ,,	...	...	...	...	·180	80	·922	...	...	
	Midnight	...	...	...	...	·170	79	·914	...	...	
Shahjehan	10 A.M.	...	...	...	...	30·000	83	29·804	N. W.	3	Light breeze and clear weather—sea smooth. Current S. 43° E. 21 miles.
	Noon	13° 54′ N.	14° 9′ N.	81° 4′ E.	81° 18′ E.	...	...	...	...	...	
	4 P.M.	...	14° 28′ N.	...	81° 21′ E.	29·000	86	·708	N. N. E.	2	
City of Canterbury	4 A.M.	...	18° 27′ N.	...	87° 00′ E.	29·830	...	29·855	S.	2	4 A.M.—Southerly swell, cloudless. 8 A.M.—Southerly swell, with showers to the westward. Noon.—Southerly swell, with light clouds overhead; rain to westward. 4 P.M.—Southerly swell, clear overhead; hazy on horizon. 8 P.M.—Southerly swell, fine, clear, with small clouds on horizon.
	8 ,,	...	17° 51′ N.	...	87° 43′ E.	·900	...	·925	S.	2	
	Noon	17° 13′ N.	...	86° 25′ E.	...	·890	...	·915	S. E	3	
	4 P.M.	...	16° 35′ N.	...	86° 08′ E.	·830	...	·855	S. by E.	3	
	8 ,,	...	15° 57′ N.	...	86° 51′ E.	880	...	·905	S. S. E.	1	
	Midnight	...	15° 19′ N.	...	85° 34′ E.	·880	...	·905	S. E. by E.	3	
Memnon	Noon	19° 35′ N.	19° 33′ N.	88° 00′ E.	...	29·950	...	...	E.S.E.	1 & 2	Fine, clear throughout; slight current to westward.
Belfast of Liverpool	4 A.M.	...	...	...	...	29·916	85	29·775	S.	1	Light airs and calms throughout, with remarkably clear sky. Lightning in the west-south-west in the evening. Strong current running to west-south-west. A nearly clear sky throughout the 24 hours.
	8 ,,	...	...	...	...	...	...	...	Calm	...	
	10 ,,	...	...	...	...	30·008	86	·864	Calm	...	
	Noon	20° 34′ N.	...	87° 34′ E.	...	29·976	87	·829	Calm	...	
	4 P.M.	...	...	...	...	·926	89	·774	S.	...	
	8 ,,	...	...	...	...	...	...	...	..	1	
	10 ,,	...	...	...	...	30·002	87	·855	S.	2	
	Midnight	...	...	...	...	...	...	...	...	...	
Nith	Noon	20° 40′ N.	...	87° 54′ E.	...	29·800?	...	...	...	...	Noon.—Calm and clear, south-west to west-south-west winds. Current 41 miles.
F. L. V. Star	10 A.M.	Mutla Station.		...	...	30·000	84	29·861	S. by N.	1	Sea smooth.
	4 P.M.	...	...	...	...	29·924	86	·770	Calm	...	
F. L. V. Meteor	10 A.M.	Eastern Channel Station.		...	...	29·950	86	29·856	Calm	...	Sea smooth, slight swell.
	4 P.M.	...	...	...	...	·850	88	·752	Calm	...	
F. L. V. Comet	10 A.M.	Intermediate Station.				30·020	84·5	29·870	Calm	...	Swell from south-south-east Sea smooth; calms throughout the day. Light variable airs during the night.
	4 P.M.	...	...	...	...	29·924	87·5	·766	Calm	...	
Mahratta	8 A.M.	Chittagong River.		...		29·990	85	29·839	Calm	...	Fine clear weather. Light breeze and fine.
	Noon	...	21° 50′ N.	...	91° 30′ E.	30·070	85	·919	...	...	
	4 P.M.	...	21° 30′ N.	...	91° 10′ E.	·070	85	·919	...	...	
	8 ,,	...	...	...	...	·040	85	·889	S.	...	
	Midnight	...	...	...	...	·070	84	·921	...	...	

From the preceding summary of the information, it is evident that calms or light variable winds were experienced by all the vessels in the north of the Bay. To the north of lat. 11°, the winds varied in strength from 0 to 4. Near the head of the Bay, *i.e.*, to the north of lat. 20°, calms were experienced by every one of the seven vessels from which logs have been obtained. Over the south of the Bay, moder-

ately strong, but somewhat unsteady, south-west monsoon winds, of force 5 or 6 (as are indicated by the Port Blair and Nancowry returns) were blowing, and giving local showers of little or no importance. Between this region of rapid horizontal motion in the south of the Bay and the area of calms, there was a belt or narrow area in which the air brought northwards by the south-west winds was carried off vertically. The existence of this ascending current follows from theoretical considerations.

There is hence no evidence in the meteorology of the Bay as indicated by the ships' logs, or of the land area as given by the land observations, for the existence of a barometric depression in any part of the Bay, or of cyclonic circulation. The following were the conditions at this time:—

(1) Almost absolute uniformity of pressure over the whole of Northern and Central India, and over nearly the whole of the Bay.

(2) The prevalence of light variable airs or calms over Northern and Central India, and the north of the Bay.

(3) Fine weather, clear skies, a calm sea, and a moderately high temperature, over the northern half of the Bay.

(4) Moderately strong south-west winds in the south of the Bay. This formed one part of a general atmospheric circulation, which almost certainly gave rise to an ascending current over the centre of the Bay.

These were the atmospheric conditions immediately antecedent to the cyclone, and as they are the conditions which experience has shown to precede the formation of all recent cyclones in the Bay, it may be assumed that they favour, even if they are not essential to, the generation and development of a cyclonic vortex in the Bay.

October 8th.—The following gives the observations taken at the coast stations of the Bay of Bengal, and also at the more important second class observing stations throughout India, at 10 A.M. of this day :—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Direction.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·992	+·038	SW	...	13	191	0·05	*g.*
Galle	29·989	+·107	NW	...	12	171	0·33	*g.*
Trincomalee	29·915	+·075	W	...	14	140	0·25	...
Negapatam	29·932	+·007	SW	...	2	47	...	...
Madras	29·927	+·016	NW	...	4	78	...	*o.*
Vizagapatam	29·912	+·013	SE	E by S	1	48	...	*b.*
Gopalpore	29·912	?	N	SW	3	?	...	*b.*
False Point	29·925	+·016	SE	SSE	?	?	...	*b.*
Saugor Island	29·915	+·017	WSW	SSW	5	86	...	*b. c.*
Chittagong	29·925	+·004	Calm	W	2	63	...	*b. c.*
Akyab	29·922	+·008	E	WNW	2	87	...	*b. c.*

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Direction.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Diamond Island	29·944	+·024	SE	SSW	10	152	...	*b.*
Port Blair	29·923	+·060	SSE	SW	6	91	0·12	*b v.*
Nancowry	29·920	+·030	WSW	WSW	6	92	...	*o.*
Calcutta	29·916	+·004	NW	WSW	2	59	...	*b c.*
Patna	29·925	+·007	WNW	NNW	1	56	0·07	*c.*
Allahabad	29·903	—·023	ESE	Calm	1	77	...	*b.*
Lucknow	29·886	—·035	NNW	WNW	1	56	...	*b.*
Lahore	29·861	—·047	Calm	Calm	1	56	...	*b.*
Bombay	29·969	+·030	SSW	NW	9	93	...	*b.*
Nagpur	29·917	—·020	Calm	NW	3	91	...	*c.*

The atmospheric conditions of the land area were practically identical with those of the preceding day. There was even more strongly marked uniformity. Pressures on the opposite coasts of the Bay were almost identical, the average pressure at the east coast stations being 29·922″ and of the west coast stations 29·919″, a difference of only ·003″. Over Northern Bengal, pressure was also approximately uniform, and slightly lower than over the coast area of the Bay.

Winds were very light and variable everywhere. Calms were recorded at an unusually large number of stations. The amount of the wind motion at this time is shown by the following statement :—

	Average air motion in miles per hour, October 8th, 1882.	Normal average air motion in miles per hour, October.	Percentage of actual to normal air motion.
Bengal	3·3	2·7	122·2
North-Western Provinces	2·6	2·3	113·0
Punjab	1·2	1·9	63·2
Central Provinces	2·9	2·7	107·4

In Upper India, winds were generally westerly, the cold weather direction. They were easterly in the North-Western Provinces to the east of Allahabad and in Behar, and southerly in Bengal, indicating that if they were not mere local winds, they were the feeble continuation of the ordinary south-west monsoon winds, which had not yet been displaced from Bengal.

Fine clear weather prevailed over the whole of Northern and Central India.

The following summary of the meteorological information, extracted from the logs of vessels in the Bay at this time, gives the state of the weather in the Bay:—

Vessels.	October 8th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	Dr.	Obsd.	Dr.	Height.	Attd. Therm.		Dir.	Force.	
Erin's Gem	4 A.M.	...	...	...	...	...	...	...	S. S. W.	5	4 A.M.—Moderate breeze, fine weather. 9-30 A.M.—Light winds, very light current to north-east. Squalls and rain. Noon.—Moderate winds from south. Squalls and rain from 6 P.M. to midnight.
	9-30 ,,	...	...	...	...	29·900	...	29·950	S. by W.	5	
	Noon	0° 33′ S.	0° 52′ S.	78° 20′ E.	78° 14′ E.	·890	...	·940	S.	4	
	4 P.M.	...	...	...	...	...	...	...	...	4	
	8 ,,	...	...	...	...	...	...	...	Variable	3	
	Midnight	...	...	...	...	...	...	...	S. S. W.	3	
Kerbela	4 A.M.	...	...	...	...	30·140	78	29·887	S. W.	2	A.M.—Light variable airs with heavy rain squalls, and thick weather. Noon.—Wind from south-west increasing to a fresh gale, with thick rainy weather. 6 P.M.—Wind strong from south-west, with occasional squalls. Sea moderately high from south-west.
	8 ,,	...	...	...	...	·220	76	·973	...	...	
	Noon	8° 00′ N.	8° 13′ N.	77° 13′ E.	77° 22′ E.	·210	76	·963	...	5	
	4 P.M.	...	...	...	...	·120	76	·873	...	8	
	10 ,,	7° 14′ N.	...	...	...	·180	76	·933	...	...	
	Midnight	...	...	...	...	·200	79	·944	...	5 & 6	
Atlantique	Noon	...	12° 06′ N.	...	80° 24′ E.	29·882	...	29 907	...	...	Stormy, overcast.
	4 P.M.	...	...	...	80° 26′ E.	·843	...	·868	...	...	Cloudy, calm.
	8 ,,	...	12° 09′ N.	...	80° 30′ E.	·882	...	·907	E. S. E.	1	Variable, fine.
	Midnight	...	12° 14′ N.	...	80° 41′ E.	·843	...	·868	S.	3	
City of Canterbury	4 A.M.	...	14° 41′ N.	...	85° 17′ E.	29·810	...	29·835	S. E. by E.	3	4 A.M.—Southerly swell, cloudy weather. 8 A.M.—Southerly swell, dull cloudy weather, with rain clouds all round. Noon.—Southerly swell, cloudy, with rain clouds in south-west quarter. 4 P.M.—Southerly swell, cloudy, with heavy rain in south-west quarter. 8 P.M.—South-west swell, clear overhead, cloudy to south-west. Midnight.—Moderate sea, heavy rain squalls.
	8 ,,	...	14° 03′ N.	...	85° 00′ E.	·900	...	·925	E. S. E.	3	
	Noon	13° 25′ N.	...	84° 46′ E.	...	·910	...	·935	S. S. W.	3	
	4 P.M.	...	12° 49′ N.	...	84° 32′ E.	·840	...	·865	W. N. W.	4	
	8 ,,	...	12° 13′ N.	...	84° 18′ E.	·870	...	·895	W.	3	
	Midnight	...	11° 37′ N.	...	84° 04′ E.	·880	...	·905	S. W.	5	
Bancoora	4 A.M.	...	...	...	...	29·980	84	29·811	N.E. by N.	2	
	8 ,,	...	...	...	...	30·080	86	·906	...	2	
	Noon	15° 04′ N.	15° 26′ N.	81° 48′ E.	81° 50′ E.	...	...	...	N.E. by N.	2	Light breeze and smooth water.
	4 P.M.	...	...	...	...	29·990	86	·818	N. N. E.	2	
	8 ,,	...	...	...	...	30·020	85	·849	N. E.	2	
	Midnight	...	...	...	...	·020	85	·849	N. E.	2	
Shahjehan	10 A.M.	16° 50′ N.	...	82° 27′ E.	...	30·020	85	29·909	N. N. E.	2	Light breeze and hazy.
	Noon	Coconada Roads.			...	...	...	...	...	...	
	4 P.M.	...	...	...	...	29·930	86	·816	Calm	1	Sea smooth.
Madura	4 A.M.	...	...	...	...	29·970	87	29·883	E.	1	Noon.—Slight swell from south. Clear sky. Slight current to north-west. 8 P.M.—Low clouds in the eastern horizon with lightning occasionally.
	8 ,,	...	...	...	...	...	...	...	E.	1	
	Noon	19° 18′ N.	...	90° 10′ E.	...	...	...	...	E.	2	
	4 P.M.	...	...	...	...	·960	89	·868	E.	1	
	8 ,,	...	...	...	...	·970	86	·886	Calm	...	
	Midnight	...	...	...	...	30·000	89	·908	...	...	
Memnon	4 P.M.	19° 54′ N.	19° 58′ N.	88° 5′ E.	...	30·000	91	...	E. S. E.	1	Fine clear weather throughout. A slight current to the westward.
Belfast of Liverpool	8 A.M.	...	...	...	...	...	...	...	S.	1	Gentle winds, calms, and fine. Clear sky, strong south-westerly current running, against which the ship can make no progress. Four ships from Calcutta have been in sight for fifty-four hours.
	10 ,,	...	...	...	...	30·050	85	29 909	S.	1	
	Noon	20° 28′ N.	...	87° 28′ E.	...	·028	88	·879	W.	1	
	4 P.M.	...	...	...	...	29·968	91	·811	Calm	...	
	8 ,,	...	...	...	...	...	...	...	Calm	...	
	10 ,,	...	...	...	...	30·020	88	·871	...	...	
	Midnight	...	...	...	...	...	...	...	S.	2	
Nith	Noon	20° 32′ N.	...	87° 40′ E.	...	29·800	...	29·900?	...	...	A.M.—Light breeze and clear. 8 A.M.—Dead calm. Noon—Calm, clear. South-west to west-south-west current 35 miles. 9-30 P.M.—Light southerly breeze.
Coconada	4 A.M.	...	...	...	...	29·810	...	...	S E	...	Light airs, and fine clear weather. Light airs, cloudy.
	8 ,,	Towards Chittagong.			...	·850	...	...	Variable	...	
	Noon.	21° 03′ N	21° 13′ N	90° 28′ E	90° 36′ E	·880	...	...	Calm	...	
	4 P.M.	...	...	...	...	·820	...	...	Calm	...	
	8 ,,	...	...	...	...	·820	...	...	...	...	
	Midnight	Anchor off Norman Light.			...	·820	...	...	Variable	...	

Vessels.	October 8th. Hour.	Latitude. Obsd.	D. R.	Longitude. Obsd.	D. R.	Barometer. Height	Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Force.	Remarks.
F. L. V. Star	10 A.M.	Mutla. Station.			...	30·058	85	29·907	S S W	1	Sea smooth.
	4 P.M.	...	...	...	...	29·960	85·5	·807	Calm	0	Ditto.
F. L. V. Meteor	10 A.M.	Eastern Channel Station.			...	30·000	86	29·906	Calm	0	Sea smooth.
	4 P.M.	...	...	...	...	29·890	85·5	·790	Calm	0	Slight swell.
F. L. V. Comet	10 A.M.	Intermediate.			...	30·054	85·5	29·901	Calm	0	Sea smooth.
	4 P.M.	Station.			...	29·954	87	·807	Calm	0	Slight swell. Light breeze from south-south-west during night.
City of Agra	Noon.	Eastern Channel.			...	29·870	86	29·850	S S W	3	Clear and fine, sea smooth.
	4 P.M.	Intermediate Light Station.			...	·880	86	·840	...	...	
	8 ,,	...	...	...	...	·900	86	·880	Calm	...	
	Midnight.	...	...	...	...	·900	85	·890	S	2	

The observations extracted from the logs of the vessels do not give as complete a view of the character of the weather in the Bay as might be wished. The facts, however, harmonize together, and indicate similar conditions in the Bay to those that usually prevail during the generation of storms.

The logs of the *Erin's Gem* and the *Kerbela* show that off the southern coast of Ceylon and India, monsoon winds, varying in force from 2 to 8, were blowing. The *City of Canterbury*, in lat. 13° 25′ N. and long. 84° 46′ E. at noon, and advancing southwards, experienced stronger winds in her southward course, and also a shift of wind during the day from east-south-east to west-north-west and back to south-west, which indicated that the weather was becoming unsettled, and that cyclonic motion was being established. The wind velocity at Port Blair and Nancowry was also above the average. Hence stronger monsoon winds than usual were blowing over the south of the Bay.

In the north of the Bay a large number of vessels contributed logs. Seven vessels were to the north of lat. 20°, and every one of them recorded calms for a part or the whole of the day. The *Nith* experienced a dead calm at 8 A.M.

In the belt between these two regions, one of calms, and the other of strong moist winds, were the *Bancoora*, *Shahjehan*, *Madura*, and *Memnon*. Their logs all agree in the facts that the winds were light, of force 1 to 2, sky clear, sea smooth, and weather fine. The most eastern of these vessels was the *Madura*, and her captain records the appearance of a low cloud on the eastern horizon with occasional lightning during the evening. This bank of clouds, the visible representation of the excessive humidity of the current of indraught on the eastern quadrant, is an almost unfailing indication of bad weather and of cyclonic motion further south in the Bay.

The meteorological conditions in the Bay were thus similar to what they had been on the 7th. The only important change or development was the commencement of unsettled weather, and the probable initiation or establishment of cyclonic motion, over a portion of the Bay (near the centre). The *City of Canterbury* was within this area, and had winds of force 3 to 5 during the day. She experienced heavy rain squalls during the latter part of the day. There was a slight southerly swell in the morning, which increased during the day, but at night there was only a moderate sea. Hence the 8th witnessed, so far as can be judged from the returns, the commencement of cyclonic motion over a small portion of the Bay.

October 9th.—The following table gives observations taken at selected stations over the coast of the Bay and in India :—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Direction.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·979	+·025	WSW	...	12	176	0 25	*o.*
Galle	29·971	+·089	NW	...	10	143	0·63	*d.*
Trincomalee	29·894	+·054	SW	...	16	160	...	...
Negapatam	29·896	—·029	SW	...	2	47	...	...
Madras	29·894	—·017	NW	...	3	59	...	...
Coconada	29·896	?	NNE	...	7	?	...	*b c.*
Vizagapatam	29·903	+·004	ESE	E by N	3	143	...	*b c.*
Gopalpore	29·906	?	N	ESE	2	?	...	*b.*
False Point	29·911	+·002	NW	E	?	?	...	*b c.*
Saugor Island	29·903	+·005	NNW	WNW	6	103	...	*c.*
Chittagong	29 903	—·018	N	WNW	2	63	...	*b.*
Akyab	29·898	—·016	E	WNW	3	130	...	*b c.*
Diamond Island	29·908	—·012	ENE	SW	4	61	0·09	*b c.*
Port Blair	29·898	+·035	SSE	WNW	5	76	0·56	*b. v.*
Nancowry	29·914	+·024	WSW	WSW	8	123	...	*o u.*
Calcutta	29·901	—·011	W	N by W	2	59	...	*b c.*
Patna	29·901	—·017	W	W	2	111	...	*b.*
Allahabad	29·888	—·038	SW	E	0	...	...	*b.*
Lucknow	29·868	—·053	WNW	WNW	2	111	...	*b.*
Lahore	29·836	—·072	Calm	Calm	0	...	...	*b.*
Bombay	29·963	+·024	SE	WNW	7	72	...	...
Nagpur	29·916	—·021	Calm	ENE	3	91	...	*b.*

The following gives the salient features of the weather in India, more especially Northern India, for the 9th. The barometer rose during the 24 hours preceding 10 A.M. over the whole of India. Great uniformity of pressure obtained throughout the Empire. The pressure in the Punjab was only ·05″ below that in Bengal, and the latter almost identical with the pressure on the Madras coast. The winds were light and variable, Calms were reported at the majority of the stations in the Punjab, Central Provinces, and Assam. The skies in the Punjab, North-Western Provinces, and Central India, were cloudless, whilst the amount of cloud was diminishing in Bengal and Bombay. They were clouded or overcast in Southern India and Ceylon, where light showers fell during the day. The following table indicates the remarkable uniformity of pressure round the coast of the Bay in this day :—

	Inches.		Inches.
Negapatam	29·896	Saugor Island	29·903
Madras	·894	Port Blair	·898
Masulipatam	·893	Diamond Island	·908
Vizagapatam	·903	Chittagong	·903
Cuttack	·901	Dacca	·903

The character of the air motion is shown by the following statement :—

Provinces.	Average air motion in miles during the 24 hours preceding 10 A.M. October 9th.	Normal average air motion in miles per day, October.	Percentage of actual to normal air motion.
Punjab	28·5	44·8	63·6
North-Western Provinces	62·4	55·4	112·6
Bengal	79·3	63·8	124·3
Central Provinces	70·1	64·6	108·5

Vessels.	October 9th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
Erin's Gem	9·30 A.M.	...	...	...	...	29·900	...	29·950	S. W.	3	Morning.—Light to moderate wind, clear fine weather. Noon.—No change. Squalls, and heavy rain during the remainder of the day.
	Noon	0° 21′ S.	0° 33′ S.	80° 30′ E.	80° 25′ E.	·840	...	·890	S. W.	3	
	4 P.M.	...	...	...	...	·760	...	·810	W.	5	
	8 ,,	...	...	...	...	...	...	...	...	4	
	Midnight	...	...	...	...	...	...	...	...	5	
Kerbela	4 A.M.	...	...	...	...	30·120	77	29·870	S. W.	6	A.M.—Strong south-west breeze and squally; overcast sky; sea smooth. 11 A.M.—Off *Galle*; wind from the west with occasional squalls and rain. Noon.—Fresh west-south-west winds and fine weather.
	8 ,,	...	...	...	...	·210	80	·951	...	...	
	Noon	5° 55′ N.	5° 56′ N.	80° 19′ E.	80° 28′ E.	·200	80	·941	...	5	
	4 P.M.	...	...	...	...	·150	80	·892	W.	...	
	8 ,,	...	...	...	...	·180	79	·924	W.	5	
	Midnight	...	...	...	...	·160	80	·902	W. S. W.	...	
City of Canterbury	4 A.M.	...	11° 01′ N.	...	83° 50′ E.	29·840	...	29·865	S. W.	3	4 A.M.—Moderate sea, cloudy; much lightning to south-west. 6 A.M.—Moderate sea, heavy rain, with thunder and lightning. Noon.—Moderate sea, with heavy rain clouds to west-south-west. 4 P.M.—Moderate sea and fine, with rain to south and west. 8 P.M.—Moderate sea with fine weather and rain to south and west.
	8 ,,	...	10° 25′ N.	...	83° 36′ E.	·900	...	·915	W.	4	
	Noon	9° 48′ N.	...	83° 21′ E.	...	·890	...	·925	W. N. W.	4	
	4 P.M.	...	9° 10′ N.	...	83° 05′ E.	·800	...	·875	W.	4	
	8 ,,	...	8° 32′ N.	...	82° 49′ E.	·850	...	·925	W.	4	
	Midnight	...	7° 54′ N.	...	82° 33′ E.	·900	...				
Atlantique	4 A.M.	...	12° 18′ N.	...	80° 53′ E.	29·804	...	29·829	W. S. W.	2	Sky cloudy, light winds.
	8 ,,	...	12° 21′	...	80° 43′	·843	...	·868	...	2	Sea smooth.
	Noon	11° 59′ N.	12° 12′	81° 5′ E.	81° 14′	·843	...	·868	...	2	
	4 P.M.	...	12° 01′	...	81° 21′	·804	...	·829	N. W.	3	Cloudy. Almost continual rain.
	8 ,,	...	12° 09′	...	81°37′	·843	...	·868	N. N. W.	3	Sea smooth.
	Midnight	...	12° 14′	...	81°55′	·804	...	·829	N.	3	
Madura	4 A.M.	...	...	...	...	29·040	88	29·851	...	...	Slight swell from south. Light fleecy clouds to the eastward. 10 A.M.—A rainbow. Noon.—Light variable airs, slight rain, cloudy sky, lightning to the eastward.
	8 ,,	...	...	...	...	·950	85	·869	E.	1	
	Noon	10° 43′ N.	...	93° 23′ E.	...	·950	90	·856	E.	1	
	4 P.M.	...	...	...	...	·920	93	·818	E.	1	
	8 ,,	...	...	...	...	·980	90	·886	S.	2	
	Midnight	...	...	...	...	·940	90	·846	S.	2	
Shahjehan	10 A.M.	...	...	...	...	30·000	85	29·889	...	1	Light airs and calms. Sea smooth, weather cloudy with light showers.
	Noon	Coconada	Roads.				85	·789	E. N. E.	3	
	4 P.M.	...	16° 55′ N.	...	83° 00′ E.	29·900		...	S. E.	2	Clear, smooth.
City of Agra	4 A.M.	...	...	...	...	29·820	...	·860	E.	3	Clear, smooth.
	8 ,,	...	...	...	...	·880	...	·860	...	...	Same weather.
	Noon	17° 28′ N.	17° 31′ N.	86° 40′ E.	86° 49′ E.	·880	...	...	E.	2	Cumuli and Cirri.
	4 P.M.	...	...	...	...	·820	...	·820	Variable	...	Showery.
	8 ,,	...	...	...	...	·840	...	...	E.	2	Cum., nim., and cir.
	Midnight	...	...	...	...	·820	...	...	Variable.	1	Fine, clear. Light current to westward.
Memnon	Noon	20° 2′ N.	19° 59′ N.	...	...	...	...	...	S.	2	Early morning.—Light southerly breeze; south-west to west-south-west current. Noon.—Calm and clear. 11 P.M.—Light breeze from south hauling to west.
Nith	Noon	20° 25′ N.	...	87° 29′ E.	...	29·800	...	...			
Belfast of Liverpool	4 A.M.	...	...	...	...	29·966	86	29·822	W. N. W.	2	Anchored at 1 A.M. Light airs and fine weather throughout. Found current running between south-south-west round to north-west from 1½ knots to 3 knots per hour.
	8 ,,	...	...	...	...	...	...	...	W.	2	
	10 ,,	...	...	...	...	30·046	88	·897	N. N. E.	2	
	Noon	20° 32′ N.	...	87° 15′ E.	...	...	...	...	Calm	...	
	4 P.M.	...	...	...	...	29·936	90	·782	Calm	...	
	8 ,,	...	...	...	...	...	...	...			
	Midnight	...	...	...	...	30·000	87	·853			

Vessels.	Hour.	Latitude.		Longitude.		Barometer.		Pr bable r du ed Barome-ter.	Winds.		Remarks.
		Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
F. L. V. Star	10 A. M.	Mutla Station.		...	...	30·040	...	29·898	Calm	...	Sea smooth.
	4 P. M.	...	...	...	...	29·922	...	·768	Calm	...	
F. L. V. Meteor	10 A.M.	Eastern Channel Station.		...	...	30·000	...	29·893	Calm	...	Sea smooth, slight swell.
	4 P. M.	...	...	...	...	·912	...	·751	Calm	...	
F. L. V. Comet	10 A. M.	Intermediate Station.		...	...	30·038	...	29·892	Calm	...	Sea smooth, slight swell, variable airs.
	4 P. M.	...	...	...	...	29·908	...	·751	Calm	...	

The preceding observations establish that light airs and calms prevailed over the head of the Bay. The light vessels near the mouth of the Hooghly had calms during the whole day. In the centre of the Bay, the winds were light, varying in force from 1 to 3. The sky was cloudy, and occasional light showers fell, as experienced by the *Madura*, in lat. 16° 43′ N., long. 93° 23′ E.; the *Shahjehan*, in lat. 16° 55′ N., long. 83° E.; and the *City of Agra*, in lat. 17° 28′ N., long. 86° 40′ E.

Over the south of the Bay, as indicated by the Port Blair and Nancowry returns, as well as by the logs of the *City of Canterbury* and the *Kerbela*, moderately strong monsoon winds, of force 4 to 6, were blowing. The *City of Canterbury*, in lat. 9° 48′ N., long. 83° 21′ E., at noon had heavy rain, with thunder and lightning at 8 A.M., but the weather is described as fine, and the sea moderate. The *Kerbela*, rounding the south coast of Ceylon, met with strong south-west breezes and occasional squalls and rain. The weather over the Bay on this day is thus clearly indicated. In the south of the Bay, south-west monsoon winds of average strength were blowing, and accompanied with occasional squalls, heavy rain showers, and a moderate sea, but the weather was of the ordinary monsoon type. Further north, in the centre of the Bay, the winds were much lighter and shifting round to east, the sea smooth, the sky cloudy, and light showers commencing to fall.

This diminution in strength of the monsoon current with its northward advance can only be explained by the assumption, that it was being converted into a vertical ascending current. This is confirmed by the tendency manifested on the 8th to the establishment of cyclonic motion, and of an area of low pressure near the centre of the Bay, and by the formation of cumuli clouds, noticed by the Captain of the *City of Agra*.

In the north of the Bay, and more especially near its northern coasts, there was hardly any air motion at all. The logs of the *Belfast of Liverpool* and other vessels show that the wind was shifting round to north. The sea was smooth, sky clear, and weather fine, but somewhat sultry. Hence the influence of the atmospheric south-west current did not extend so far north, and over the head of the Bay, a very feeble indraught was commencing, giving the first indication of the stormy cyclonic weather to the south.

October 10th.—The following are the observations taken at stations on the coast of the Bay and in India for the 10th :—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Direction.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A. M.	4 P. M.				
Colombo	29·912	—·042	WSW	...	8	118	...	...
Galle	29·908	+·026	W	...	11	110	0·20	...
Trincomallee	29·826	—·014	W	...	19	271	...	...

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Direction. 10 A.M.	Wind Direction. 4 P.M.	Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
Negapatam	29·840	—·085	SW	...	2	47	...	*b. c.*
Madras	29·852	—·059	WNW	...	3	59	0·01	*o.*
Coconada	29·866	?	NE	...	8	?	0·14	*b. c.*
Vizagapatam	29·864	—·035	NW	E by S	2	95	...	*bc.*
Gopalpore	29·868	?	NNW	SE	3	?	...	*b.*
False Point	29·875	—·034	N	NE	?	?	...	*b. c.*
Saugor Island	29·865	—·033	NNW	NNW	6	103	...	*b.*
Chittagong	29·877	—·044	NW	NNE	2	63	...	*b.*
Akyab	29·864	—·050	NE	SW	3	130	1·71	*b. c.*
Diamond Island	29·881	—·039	Calm	NNW	2	30	1·21	*b.*
Port Blair	29·854	—·009	SSE	SW	4	61	2·60	*b. v.*
Nancowry	29·874	—·016	WSW	WSW	8	123	1·30	*o.*
Calcutta	29·868	—·044	NNW	NNW	1	29	...	*b. c.*
Patna	29·883	—·035	W	W	3	167	...	*b.*
Allahabad	29·857	—·069	WSW	ESE	1	77	...	*b.*
Lucknow	29·850	—·071	WNW	WNW	2	111	...	*b.*
Lahore	29·828	—·080	E	Calm	1	56	...	*b.*
Bombay	29·923	—·016	E	NW	6	62	...	*b. c.*
Nagpur	29·884	—·053	Calm	ENE	4	121	...	*b.*

During the 24 hours preceding 10 A.M., pressure decreased over the whole of India and Burmah. The change was greater in South Madras than elsewhere. The chief feature in the distribution of pressure was, as during the previous three days, uniformity round the coasts of the Bay and in Northern India.

The equality of pressure along the east and west coasts of the Bay is shown by the following:—

Calcutta	29·868	Diamond Island	29·881
Cuttack	29·857	Akyab	29·864
Gopalpore	29·868	Chittagong	29·877
Vizagapatam	29·864	Dacca	29·870
Madras	29·852		

The same meteorological feature is indicated for Northern India by the following 10 A.M. barometric observations:—

Calcutta	29·868	Lucknow	29·850
Hazaribagh	29·868	Agra	29·863
Allahabad	29·857	Delhi	29·853

The atmospheric circulation over the Empire was that which usually obtains in October during a period of uniform pressure. Winds were very light over Upper India. Several stations recorded calms at 10 A.M. The motion, such as it was, indicated a slow transference of air down the Gangetic valley. In Bengal, winds were also unusually light and somewhat irregular. They contained, almost without exception, a strong northerly

element, showing that there, as in Upper India, the air motion was that which usually occurs at the termination of the south-west monsoon, and the commencement of the north-east monsoon. Over the whole of Central India and the Deccan, winds were north-westerly. The air was hence gradually becoming drier in Bengal. The sky was free from cloud over the whole of India, with the exception of the Madras coast, Assam, and Burmah.

The observations given in the table for stations round the coast show that pressure was below the average everywhere, the deficiency being greatest on the Coromandel coast and in the Punjab. The winds were fairly steady at the majority of stations, and were generally much below their average strength. The variations in their strength as compared with the normal at the coast stations round the Bay are striking. They were 23 per cent. stronger at Nancowry than the average, whilst they were 39 per cent. weaker at Port Blair. They were 70 per cent. weaker at Diamond Island and 30 per cent. stronger at Akyab. They were 3 per cent. stronger at Saugor Island, and 71 per cent. weaker at Calcutta. The wind returns of the coast stations thus indicate very clearly that the winds were exceedingly irregular round the coast, and that the circumstances of the air motion over the coast were much more directly related to local conditions than to the cyclonic circulation, which, the information extracted from the logs of vessels show, was now established in the Bay.

The weather on the coast of Orissa is thus described by an observer :—

The morning of the 10th commenced with light northerly and north-westerly winds, a clear sky, and fine weather. During the day the wind increased slightly, and weather continued fine with light passing clouds. Towards evening the wind hauled round slightly towards the east, and died away to light winds and calms during the evening.

Vessels.	October 10th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
Erin's Gem	4 A.M.	...	...	...	...	...	...	...	W.	5	4 A.M.—Fresh breeze and cloudy. 8 A.M.—Heavy squalls. Noon.—Fine. 4 P.M. —Squalls and rain from west to west-north-west. 8 P.M.—A squally appearance in the north-west. Midnight squally.
	8 ,,	...	...	...	...	...	...	...	W.	5	
	Noon	0° 33′ S.	0° 38′ S.	83° 10′ E.	82° 52′ E.	29·800	...	29·850	W.N.W.	5	
	4 P.M.	..	...	...	...	·760	83	·810	W.	7—6	
	8 ,,	...	...	...	...	...	...	...	...	6	
	Midnight	...	...	...	...	...	...	...	...	6	
Marion King	Noon	1° 10′ N.	...	80° 14′ E.	...	...	...	...	S.W.	4	Squalls and rain from south-west, with threatening sky from the north-west.
	4 P.M.	...	...	...	...	...	...	...	S.W.	4	
	8 ,,	...	...	...	...	...	...	...	S.W.	4	
	Midnight	...	...	...	...	...	...	...	S.W.	4	
City of Canterbury	4 A.M.	...	7° 16′	...	82° 17′ E.	29·860	...	29·885	S.S.W.	4	4 A.M.—Moderate sea. 8 A.M.—Small black clouds to north-east and east-north-east. Noon.—Moderate sea, clear, with heavy white clouds over Ceylon. 4 P.M.—Moderate sea, with heavy rain squalls. 8 P.M.—High sea, squally with clear weather.
	8 ,,	...	6° 38′	...	82° 01′	·880	...	·906	W.S.W.	6	
	Noon	6° 03′ N.	...	81° 41′ E.	...	·880	...	·905	W.S.W.	6	
	4 P.M.	...	6° 00′	...	81° 09′	·780	...	·805	W.S.W.	5	
	8 ,,	...	5° 49′	...	80° 39′	·870	...	·805	W.	5	
	Midnight	...	5° 57′	...	80° 04′	·870	...	·895	W. by S.	6	
Kerbela	5·30 A.M.	7° 23′ N.	...	...	...	30·120	80	29·862	S.W.	4—3	Moderate decreasing breeze from south-west. Calm and fine. Light increasing breeze from north-west. Towards midnight wind fresh with very dirty appearance to the north-east.
	8 ,,	...	...	...	...	·100	80	·842	Variable	...	
	Noon	8° 15 N.	8° 17′ N.	82° 51′ E.	82° 49′ E.	·140	81	·879	Variable	0	
	4 P.M.	...	...	...	...	·000	82	·737	N.W.	2	
	8 ,,	...	...	...	...	·060	81	·799	N.W.	4	
	Midnight	...	...	...	...	·090	80	·832	N.W.	6	
Atlantique	4 A.M.	...	12° 22′ W.	...	82° 7′	29·764	...	29·789	N.N.W.	3	Weather fine. Rain ceased. Steady strong breeze. Sea smooth.
	8 ,,	...	12° 26′	...	82° 16′	·804	...	·829	N.N.W.	3	
	Noon	12° 21′ N.	12° 33′	82° 15′ E.	82° 26′	·764	...	·789	W.N.W.	3	
	4 P.M.	...	12° 35′	...	82° 31′	·686	...	·711	N.N.W.	3	
	8 ,,	...	12° 37′	...	82° 52′	·705	...	·730	N.	4	
	Midnight	...	12° 28′	...	83° 25′	·725	...	·750	N.E.	3	

Vessels.	Hour.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
		Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
City of Agra	4 A.M.	...	...	...	...	29·800	...	...	E.	1—3	Clear 4 A.M., cloudy 5 to 8 A.M.
	8 ,,	...	...	...	...	·800	...	...	Variable	...	
	Noon	13° 41′ N.	13° 39′ N.	84° 54′ E.	84° 59′ E.	·780	...	...	S.	3	
	4 P.M.	...	...	...	...	·820	...	...	S.E.	2	
	8 ,,	...	...	...	...	·800	...	...	Variable	...	Cloudy with showers.
	Midnight	...	...	...	...	·840	...	...	Variable	1—5	Squally, rain, thunder, and lightning.
Bancoora	4 A.M.	...	...	...	...	30·040?	84	29·851?	E. by N.	4	Fresh breeze and cloudy, and smooth sea.
	8 ,,	...	...	...	...	·040	86	·846	E N.E.	3	
	Noon	...	16° 39′ N.	...	84° 34′ E.	·030	84	·841	E.N.E.	...	
	4 P.M.	...	...	...	...	29·930	84	·741	E.N.E.	...	Light squalls, with rain from the east.
	8 ,,	...	...	...	...	·970	84	·781	E, by N.	...	
	Midnight	...	...	...	...	·980	84	·791	E.	...	
Shahjehan	10 A.M.	...	...	...	...	29·960	82·5	29·855	E.	5	Fresh breeze and squally. Sea smooth. Moderate breeze, with easterly squalls.
	Noon	16° 44′ N.	16° 30′ N.	86° 14′ E.	86° 28′ E.	...	...	...	...	...	
	4 P.M.	...	...	...	...	·870	83	·765	E.	4	
Memnon	8 P.M.	20° 03′ N.	20° 2′ N.	88° 20′ E.	...	30·000	...	29·850	N.N.E.	3	Fine and clear.
Nith	Noon	20° 13′ N.	...	87° 35′ E.	...	29·850	...	29·850?	N.N.E.	2	Morning.—Wind light from south-west to north. Noon.—Current south-west. Weather fine and clear.
Belfast of Liverpool	4 A.M.	...	...	...	...	29·936	...	29·797	Calm	...	Light airs, calms, and fine clear weather.
	8 ,,	...	...	...	...	...	...	...	W. N. W.	1	
	10 ,,	...	...	...	...	30·000	85	29·850	...	...	Got under way, but anchored again soon afterwards; current running very strongly to the south-west.
	Noon	20° 22′ N.	...	87° 12′ E.	..	...	...	...	N. W.	2	
	4 P.M.	...	...	...	...	29·892	88	·744	N. E. to N. W.	1—2	
	8 ,,	...	...	...	...	...	...	...	Calm	...	
	11 ,,	...	...	...	...	·950	87	·806	Calm	...	
Coconada	Noon	Chittagong River off Katubdeah, towards Akyab.			...	29·750	88	...	N. E.	...	Light breeze and fine.
	4 P.M.	...	...	...	...	·720	88	...	W.	...	Light airs and fine.
	8 ,,	...	...	...	...	·740	92	...	...	...	
	Midnight	...	...	...	...	·740	93	...	...	...	
F. L. V. Star	10 A.M.	Mutla Station.			...	30·005	85	29·854	N. by E.	...	Sea smooth.
	4 P.M.	...	...	...	...	29·930	86·3	·775	Calm	...	
F. L. V. Meteor	10 A.M.	Eastern Channel Station			...	29·900	86	29·856	N. by W.	3	Sea smooth.
	4 P.M.	...	...	...	...	·820	88	·772	N. W.	1	Slight swell.
F. L. V. Comet	10 A.M.	Intermediate Station			...	30·000	85	29·849	N. W.	1	Sea smooth, slight swell from south-south-east at 9 P.M. A squall from the east-south-east with heavy rain, lightning, and thunder.
	4 P.M.	...	...	...	...	29·866	87	·710	N. W.	1	

The observations of the 10th not only show the continuation of the conditions of the 9th over the Bay, but also indicate that general cyclonic motion was now established over a large portion of the Bay.

At the head of the Bay, light winds, force 1 to 3, from north-west had set in, indicating that indraught to an area of low pressure in the Bay was now commencing. A slight swell began to come up from the south-south-east, an unfailing indication of unsettled weather and a disturbed sea in the centre of the Bay. The *Belfast of Liverpool* and *Nith* note the unusual strength of the currents near the head of the Bay, another strong indication of a cyclonic storm to the south. The reason of this is evident. The cyclonic motion of the atmosphere tends to set up a similar motion in the waters of the Bay by the frictional action between air and water, which probably increases very rapidly with increased force of the wind, and this action tends to be intensified near the head of the Bay by the peculiar shape and conformation of its shores.

In the centre of the Bay, slightly stronger easterly winds (force 3 to 5) prevailed than on the 9th. The weather was more unsettled, and squalls became more frequent. The *Shahjehan*, *Bancoora*, and *City of Agra*, which were in different parts of the centre of the Bay, all report the occurrence of squalls with rain during the day. The wind directions observed by the *City of Agra* confirm the land observations in placing the central depres-

sion and disturbance not far from the west coast, and probably between lat. 12° and 16° N. Over the south of the Bay, as indicated by the logs of the *Kerbela*, *City of Canterbury*, and *Marion King*, strong west to south-west winds now prevailed. The increased indraught to the central disturbance gave rise to heavy rain squalls, a high sea, and threatening weather. The humidity of this current was evidenced by the heavy cumuli clouds observed by the *City of Canterbury* to be hanging over the Ceylon hills.

Hence the observations indicate clearly the development of the conditions of the preceding day. Cyclonic motion was already established between lat. 12° N. and 18° N. and long. 88° E. and 82° E., and was maintained mainly by an indraught of a strong humid current from the south.

October 11th.—The following table gives observations taken at the land observatories for the 11th of October :—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·968	+·014	SW	?	11·0	162	0·10	*o.*
Galle	29·874	—·008	W	?	12·0	171	2·38	*o.*
Trincomalee	29·785	—·055	SW	?	13·0	130	0·48	...
Negapatam	29·814	—·111	W	?	2·0	47	0·06	*o.*
Madras	29·818	—·093	NNW	?	6·0	118	0·09	*o.*
Coconada	29·832	?	NE	?	8·0	?	...	*b. c.*
Vizagapatam	29·834	—·065	NE	NE	3·0	143	...	*b. c.*
Gopalpore	29·834	?	NE	ESE	4·0	?	...	*b.*
False Point	29·847	—·062	N	NE	?	?	...	*b.*
Cuttack	29·833	—·082	NE	NE	2·0	95	...	...
Saugor Island	29·816	—·082	NNW	SSW	5·0	86	...	...
Chittagong	29·835	—·086	ESE	SSW	1·0	31	...	...
Akyab	29·860	—·054	ESE	S	2·0	87	...	*b. c.*
Diamond Island	29·863	—·057	ESE	E	5·0	76	1·06	...
Port Blair	29·818	—·045	WSW	WSW	7·0	106	2·00	*o. u.*
Nancowry	29·854	—·036	WSW	WSW	5·6	86	7·60	...
Calcutta	29·834	—·078	Calm	NW by W	1·0	29	...	*b. c.*
Patna	29·858	—·060	SSW	S	2·0	111	...	...
Allahabad	29·822	—·104	NE	NE	1·0	77	...	*b.*
Lucknow	29·821	—·100	Calm	Calm	1·0	56	...	*b.*
Lahore	29·810	—·098	E	Calm	1·0	56	...	*b.*
Bombay	29·865	—·074	ENE	NW	9·0	93	...	*b. c.*
Nagpur	29·839	—·098	Calm	ENE	4·0	121	...	...

The barometer continued to fall over nearly the whole of India. The fall was less in Burma, and at the Andamans and Nicobars, than over Northern India. It was

greatest on the Coromandel Coast, and in the central and eastern districts of the North-Western Provinces. No change had taken place at the Ceylon stations, and moderate gradients were established over the south of the Bay. Over the whole of North and North-Eastern India, pressure was remarkably uniform. This feature was very strongly marked round the coasts of the Bay, as the following selection of observations shows:—

	10 A.M.		10 A.M.
Chittagong	29·835	Vizagapatam	29·834
Cuttack	·833	Coconada	·832
Gopalpore	·834	Calcutta	·834

Although the land observations of this day establish the fact of great uniformity of pressure over a large part of India, and more especially over the north and west coasts of the Bay, the wind directions indicate clearly the existence of cyclonic motion in the Bay. They were south-east in Arakan, north-east on the coast of Orissa and the Northern Circars, north-north-west at Madras, and west at Negapatam. There was an area of low pressure (the minimum being 29·75″) in the Punjab, whilst pressure was slightly higher in Burma, and along the western coast of India, than elsewhere. The following barometric observations at 10 A.M. indicate the distribution of pressure over the land area:—

East coast of the Bay.	Inches.	West coast of the Bay.	Inches.	Northern India.	Inches.
Nancowry	29·854	Negapatam	29·814	Hazaribagh	29·834
Port Blair	·818	Madras	·813	Allahabad	·822
Akyab	·860	Masulipatam	·818	Agra	·835
Chittagong	·835	Vizagapatam	·834	Lahore	·810
		Saugor Island	·816	Peshawur	·750

Whence, as before, the differences over the land area were very slight.

Winds over the greater part of Northern and Western India were now drawing round to their cold-weather directions (between north-west and north-east). They were, as on previous days, very light, and calms were recorded at a large number of stations. They were considerably above average strength at Colombo, and to a less extent at Vizagapatam, Madras, and Port Blair. Over the whole of Central and Northern India, light winds ranging in velocity from 1 to 2 miles an hour prevailed. Skies were clear in the Punjab, North-Western Provinces, Behar, Western Bengal, Central Rajputana, and were overcast on the Coromandel Coast. Rainfall over the land area was at this time restricted to Upper Assam, Burma, the Madras Coast, and Ceylon.

The weather in Bengal and Orissa was fine with clear skies, and light, and in many cases, variable or local winds. The weather of the 11th at False Point is thus described by the Light-house-keeper: "The 11th commenced with light winds, clear skies, and light hazy weather. The haze cleared up about 8 A.M., and the winds from the north and north-east were light, and the weather fine and clear, during the remainder of the day.

Vessels	October 11th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Erin's Gem	4 A.M.	...	...	...	...	...	...	...	W.	6	4 A.M. Fresh breeze; cloudy;
	9·30 ,,	...	...	...	...	29·440	...	29·590	...	6	strong showers; 9-30 A.M.
	Noon	2° 56′ N	2° 58′ N	85° 50′ E	85° 33′ E	·770	...	·820	W. S. W.	6	hard squall and rain; much
	4 P.M.	...	...	...	...	·700	...	·850	S. W.	6	lightning from 9 to 11 A.M.
	8 ,,	...	...	...	...	...	...	...	W.	5	Squally appearance at noon;
	Midnight	...	...	...	...	...	...	...	...	4	considerable sea from south-west; raining; threatening weather. Vivid lightning to north-west, hard squalls. Midnight squally.
Marion King	4 A.M.	...	...	...	...	...	...	...	...	6	Hard squalls and rain and rising sea.
	8 ,,	...	...	...	...	...	...	...	...	7	
	Noon	...	4° 7′ N	...	83° 15′ E	...	...	...	S. W.	7	Blowing fresh from south-west, with threatening sky to the north-west.
	4 P.M.	...	...	...	...	...	...	...	...	6	
	8 ,,	...	...	...	...	...	...	...	...	6	
Castore	4 A.M.	...	...	...	...	30·158	...	...	...	...	Sea high.
	8 ,,	...	...	...	...	·197	...	...	...	...	
	Noon	6° 08′ N	6° 08′ N	...	85° 35′ E	·119	...	...	W.	3	
	4 P.M.	...	...	...	...	·040	...	...	...	...	
	8 ,,	...	...	...	...	·119	...	...	...	...	
	Midnight	...	...	...	...	·119	...	...	...	...	
City of Canterbury	4 A.M.	...	6° 04′	...	79° 32′	29·820	...	29·845	W.	5	High sea, showery and cloudy.
	8 ,,	...	6° 11′	...	79° 00′	·870	...	·895	W. S. W.	5	High sea, light clouds overhead, and clear.
	Noon	6° 17′ N	...	78° 28′ E	...	·840	...	·865	W.	5	High sea, light clouds to north and clear.
	4 P.M.	...	6° 23′	...	77° 49′	·770	...	·795	W.	5	High sea, heavy rain, squalls and overcast.
	8 ,,	...	6° 30′	...	77° 16′	·860	...	·885	W.	5	Ditto ditto.
	Midnight	...	6° 37′	...	76° 43′	·860	...	·885	W.	5	Ditto *ditto.*
City of Agra	4 A.M.	...	...	...	...	29·800	...	29·780	S. W.	3	Dark and gloomy.
	8 ,,	...	...	...	...	·820	...	·800	S. S. W.	3	Squally, cloudy.
	Noon	9° 53′ N	9° 55′ N	83° 22′ E	83° 16′ E	·830	...	·810	S. S. W.	3	6 P.M.—Hard west-south-west squall. 8 P.M.—Rain and lightning to south-west.
	4 P.M.	...	...	...	...	·780	...	·760	S. W.	2-4	
	8 ,,	...	...	...	...	·840	...	·820	S.	2-3	
	Midnight	...	...	...	...	·860	...	·840	...	...	
Kerbela	4 A.M.	...	...	...	...	30·000	79	29·745	N. W. / N. N. E.	6	A.M.—Fresh breeze and overcast, with occasional squalls and rain. Noon.—Wind light and variable with rain. After noon, wind increasing, and thick squally, rainy weather.
	8 ,,	...	...	...	...	·030	79	·775	Variable	...	
	Noon	12° 3′ N	11° 59′ N	84° 30′ E	84° 25′	·060	80	·802	...	2	
	4 P.M.	...	...	...	...	·050	82	·787	...	...	
	8 ,,	...	...	...	...	·020	80	·762	N. E.	...	
	Midnight	...	...	...	...	·060	80	·802	...	...	
Atlantique	4 A.M.	...	...	...	83° 0′	29·686	...	29·711	N.E.	3	Cloudy, squalls.
	8 ,,	...	...	...	...	·725	...	·750	E.N.E.	4	Sea smooth.
	Noon	13° 01′ N.	12° 51′ N.	83° 9′ E.	...	·725	...	·750	..	1	
	4 P.M.	...	...	...	83° 16′	·646	...	·671	N.E.	3	Sky overcast. Squalls with much rain.
	8 ,,	...	...	...	...	·686	...	·711	E.N.E.	1	
	Midnight	...	...	...	83° 31′	·686	...	·711	N.E.	3	
Duke of Devonshire	4 P.M.	Madras		...	...	29·740	...	29·780	N. E.	2	Moderate wind, and rough sea
	8 ,,	...	...	...	...	·770	...	·810	...	...	Sky heavily overcast; frequent showers.
	Midnight	...	...	...	...	·760	...	·800	...	...	
Clan Macdonald	4 A.M.	...	...	...	...	...	...	...	N. E.	3	Thunder, lightning, showers;
	8 ,,	...	...	...	...	...	...	...	Variable.	3	frequent squalls; sea smooth;
	Noon	...	15° 01′ N.	...	82° 04′ E.	29·750	...	29·760	...	...	sun obscured.
	4 P.M.	...	...	...	...	...	...	...	Unsteady.	4	Heavy rain during squalls, with
	8 ,,	...	...	...	...	...	...	...	N. E.	...	loud thunder; clearing up a little at sundown.
	Midnight	...	...	...	...	...	...	...	...	...	
Bancoora	4 A.M.	...	...	...	...	29·940	82	29·757	...	...	Lightning to eastward. Moderate wind and smooth sea.
	8 ,,	...	...	...	...	30·020	86	·826	E. by N.	...	
	Noon	15° 53′ N.	16° 11′ N.	88° 21′ E.	88° 28′ E.	29·980	87	·783	...	3	Squally at times with heavy rain.
	4 P.M.	...	...	...	...	·910	83	·724	Unsteady.	...	
	8 ,,	...	...	...	...	·960	82	·777	E.	2	
	Midnight	...	...	...	...	·960	83	·774	E. by S.	...	
Shahjehan	10 A.M	...	...	...	...	29·910	83	29·804	E.	3	Moderate breeze; clear weather; sea smooth.
	Noon	16° 22′ N.	16° 2′ N	90° 20′ E.	90° 24′ E.	...	...	...	...	...	
	4 P.M.	...	...	...	..	29·810	83	·705	E.	3	South-south-west swell.
Memnon	4 P.M.	19° 54′ N.	18° 51′ N.	88° 55′ E.	...	30·000	...	...	N. E.	3	Fine and clear.
Coconada	4 A.M.	Off Oyster Reef Light-house. Akyab Harbour.				29·740	...	...	C Im	...	Hazy with lightning in the
	8 ,,					·750	...	...	Variable	...	south-east and south-west.
	Noon					·740	...	...	...	...	Noon—Light airs and thun-
	8 P.M.	...	...	...	...	·730	...	...	Calm	...	der, lightning, and heavy rain. 8 P.M.—Calm and fine.
Nith	4 A.M.	...	...	...	...	...	...	...	Calm	...	Noon—Weather fine and clear;
	8 ,,	...	...	...	...	...	...	...	N. N. E.	2	current south-west 20 miles.
	Noon	20° 7′ N.	...	87° 40′ E.	...	29·800	...	...	N. N. E.	2	
	4 P.M.	...	...	...	...	...	...	...	N. N. E.	2	
	8 ,,	...	...	...	...	...	...	...	E. S. E.	2	Midnight.—Very strong outh-west current.
	Midnight	...	...	...	...	...	...	...	...	...	

Vessels.	October 11th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Belfast of Liverpool	4 A.M.	...	...	...	...	29·892	...	...	N. N. W.	2	Calms and light airs with very clear sky; fine weather. A light bank of clouds in the eastern horizon before sunrise. This is the first eastern cloud bank seen for many days. Noon—Strong south-west current.
	6½ ,,	...	...	...	...	·920	84	29·781	N.	2	
	10 ,,	...	...	...	...	·978	88	·829	N.	2—3	
	Noon	20° 22′ N.	...	87° 12′ E.	...	...	...	...	...	...	
	2½ P.M.	...	...	...	...	·890	89	·739	N. N. E.	2	
	3 ,,	...	...	...	...	·872	89	·721	...	...	
	4 ,,	...	...	...	...	·870	...	·719	N. N. E.	2	
	8 ,,	...	...	...	...	·940	88	·731	E. S. E.	1	
	9 ,,	...	...	...	...	·952	88	·803	E. N. E.	2	
	9½ ,,	...	...	...	...	·964	...	·815	...	...	
	10 ,,	...	...	...	...	·970	88	·821	E.	3	
F. L. V. Star	10 A.M.	Mutla.		...	...	29·974	86	29·820	E. by N.	1	Sea smooth.
	4 P.M.	...	...	...	...	·885	86	·732	S. E by E.	2	Ditto.
F. L. V. Meteor	10 A.M.	Eastern Channel.		...		29·900	87	29·803	N. E.	1	Sea smooth.
	4 P.M.	...	...	...	...	·800	87·5	·703	E.	1	Slight swell.
F. L. V. Comet	10 A.M.	Intermediate Station.		...		29·964	86·5	29·809	N.	1	Sea smooth; a slight swell from south-south-east; thunder to west.
	4 P.M.	...	...	...	...	·850	87·5	·693	S. E.	1	

The above extracts give tolerably complete information of the weather over the Bay on the 11th. At and near the entrance to the Bay, strong west to south-west winds, of force 5 to 7, were blowing during the day. Frequent squalls with heavy rain were experienced by all the vessels, including the *Erin's Gem*, *Marion King*, *Castore*, *City of Canterbury*, and *City of Agra*, in this part of the Bay.

Further north, between lat. 10° N. and 16° N., the winds were not so strong and far less steady, varying in strength from 1 to 6. Over the whole of this part of the Bay, frequent rain showers occurred with squalls. A slight barometric depression had now formed (*vide* Plate XX), and the winds, as recorded in the logs, indicate cyclonic indraught of moderate intensity in the southern quadrant. The *Kerbela* in lat. 12° 3′ N. and long. 84° 30′ E. appears to have been near to the centre of the depression, and passed into the northern quadrant early in the morning. This vessel, as well as the *Atlantique*, *Duke of Devonshire*, *Clan Macdonald*, and *Bancoora*, had variable unsteady winds of average force 3, with occasional or frequent squalls and rain. To the north of lat. 16° N., the weather was fine and clear, sea smooth, winds light to moderate, except near the head of the Bay or to the north of lat. 20° N., where there was no perceptible air motion. The *Coconada* and *Belfast* both record calms during the day. The captain of the *Belfast* notes the appearance of a light bank of clouds in the eastern horizon before sunrise, and states that it was the first eastern cloud seen for many days.

Hence the conditions in the Bay are clearly indicated by the above. A large shallow depression had now formed between lat. 10° N. and 16° N., which was being fed by a strong moist southerly current giving heavy rain over the whole of this part of the Bay. To the north of this area, moderate northerly winds had set in, but had barely extended beyond lat. 18° N., except as light airs and calms. The thick hazy weather observed further northwards indicated a saturated atmosphere, whilst the appearance of low banks of clouds in the east or south-east was probably another evidence of the same fact, *viz.*, an atmosphere almost surcharged with vapour.

October 12th.—The more important observations taken at the Indian land stations for the 12th of October are as follows:—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·878	—·076	SW	?	13·0	191	0·25	*o.*
Galle	29·881	—·001	WNW	?	12·0	171	0·68	*o.*
Trincomalee	29·801	—·039	SW	?	14·0	140	0·06	*o.*
Negapatam	29·813	—·112	SW	?	2·0	47	...	*b. c.*
Madras	29·834	—·077	NW	?	6·0	118	0·17	*o.*
Coconada	29·801	?	NE	?	13·0	?	...	...
Vizagapatam	29·818	—·081	NE	E by N	4·0	190	...	*b. c.*
Gopalpore	29·848	?	NE	S	5·0	?	...	*b.*
False Point	29·867	—·042	ENE	NE	?	?	...	*b. c.*
Cuttack	29·849	—·066	NE	ENE	3·0	143	...	*Sultry.*
Saugor Island	29·869	—·029	NE	SE	5·0	86	...	...
Chittagong	29·890	—·031	ENE	NNE	3·0	94	...	...
Akyab	29·896	—·018	ESE	SE	2·0	87	0·13	*b.c.*
Diamond Island	29·892	—·028	Calm	SE	14·0	212	3·79	*o.*
Port Blair	29·856	—·007	SW	WSW	6·9	105	0·17	*o.p.*
Nancowry	29·898	+·008	WSW	WSW	14·4	222	1·41	*o.*
Calcutta	29·894	—·028	E	E	1·0	29	...	*b.c.*
Patna	29·932	+·014	E	NE	3·0	167	...	...
Allahabad	29·889	—·037	Calm	NE	1·0	77	...	*b.*
Lucknow	29·886	—·035	NNW	Calm	1·0	66	...	*b.*
Lahore	29·879	—·029	SE	Calm	1·0	56	...	...
Bombay	29·957	+·018	ENE	NNW	10·0	103	...	*b.*
Nagpur	29·861	—·076	NNE	NE	4·0	121	...	*b*

During the previous three days, the barometer had fallen over the whole of India through nearly a tenth of an inch. This phase of a general oscillatory movement of the barometer, and therefore probably of the atmosphere, was now followed by the opposite movement, or by an equally well-marked general rise, which continued during the following 24 hours. These general and approximately uniform and simultaneous movements of the atmosphere, as was pointed out in the account of the south-west Monsoon storm of the 18th to 21st September 1878 (Indian Meteorological Memoirs, Vol. II, Part I, pages 22-3), have no relation to peculiarities of weather in one district, such as, for example, the formation of a cyclonic vortex. They are apparently due to small vertical oscillations of this atmosphere, the nature of which has not yet been fully worked out. The barometer fell on the Coromandel Coast. This was evidently due to the development of the cyclonic storm. The rise was greatest in the Punjab and western districts of the North-Western Provinces. North-east winds now prevailed over the whole of Bengal, and as far west as Nagpur and Berar, and over the greater part of the Peninsula.

Vessels.	October 12th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Er ns' Gem	4 A.M.	...	...	...	...	...	...	...	S.W.	4	A.M.—Threatening weather.
	9-30 ,,	...	...	...	...	29·810	...	29·860	S.W.	4	1 A.M.—Terrific squall from
	Noon	5° 12′ N.	5° 12′ N.	87° 12′ E.	86° 56′ E.	·800	...	·850	S.W.	5	north-west of one hour's du-
	4 P.M.	...	...	...	...	·740	...	·790	S.W. by S	5	ration. 4-30 A.M.—Very hard
	9-30 ,,	...	...	...	...	·530	...	·580	S.W. by S.	5	squall from south-west. At
	Midnight	...	...	...	...	...	...	...	S.W.	5	noon, sun shone through
									S.W.	4	dense haze. Midnight, mode-
											rate breeze from south-west.
City of Agra	4 A.M.	...	...	...	...	29·820	...	29·800	S.S E.	2	4 A.M.—Cloudy, sea smooth.
	8 ,,	...	...	...	...	·880	...	·860	S.W.	3—4	8 A.M.—Cloudy, sea confused.
	Noon	6° 21′ N.	6° 39′ N.	81° 44′ E.	81° 32′ E.	·880	...	·860	S.W.	5	NOON.—squally, sea moderat-
	4 P.M.	...	...	...	...	·820	...	·800	W.S.W.	4	ing. 4 P.M.—Sea south-west-
	8 ,,	...	...	...	...	·900	...	·880	W.	4	erly, confused; sky clouded.
	Midnight	...	...	...	...	·920	...	·900	W.S.W.	4	8 P.M.—West-south-westerly
											sea, squally and rain.
Marion King	8 A.M.	...	...	...	...	...	...	...	...	5	Squalls with rain, varying
	Noon	...	7° 25′ N.	...	84° 25′ E.	...	...	...	S.W.	6	winds, and heavy hanging
	4 P.M.	...	...	...	...	...	...	...	...	6	clouds. Smooth sea.
Castore	Noon	...	9° 23′ N.	...	82° 59′ E.	·158	...	...	W.	...	Sea rough.
Atlantique	4 A.M.	...	13° 26′ N.	...	83° 35′ E.	29·646	...	29·671	E.	4	Morning, cloudy; wind vari-
	8 ,,	...	13° 52′ N.	...	,, 37′ E.	·725	...	·750	E.N.E.	4	able; sea smooth. Afternoon,
	Noon	14° 05′ N.	14° 10′ N.	83° 48′ E.	,, 47′ E.	·725	...	·750	...	4	weather rainy; wind irregu-
	4 P.M.	...	,, 31′ N.	...	,, 51′ E.	·686	...	·711	E.	4	lar and very variable.
	8 ,,	...	,, 36′ N.	...	,, 58′ E.	·725	...	·750	S.E.	2	
	Midnight	...	,, 42′ N.	...	84° 15′ E.	·725	...	·750	N.	3	
Duke of Devonshire	4 A.M.	...	...	...	...	29·760	...	29·780	N.E.	4	Moderate wind with strong
	8 ,,	...	...	...	...	·760	...	·780	...	4	squalls, heavy showers; vivid
	Noon	15° 35′ N.	...	82° 44′ E.	...	·760	...	·780	...	5	lightning; sky having a very
	4 P.M.	...	...	...	...	·740	...	·760	...	5	heavy gloomy appearance;
	8 ,,	...	...	...	...	·770	...	·790	...	5	rough sea.
	Midnight	...	...	...	...	·750	...	·770	...	6	
Baucoora	4 A.M.	...	...	...	...	29·000	82	29·717	E by S.	3	Moderate breeze and cloudy,
	8 ,,	...	...	...	...	30·000	82	·817	...	4	squally with rain. Smooth
	Noon	...	15° 38′ N.	...	92° 12′ E.	·020	81	·839	...	3 to 6	sea.
	4 P.M.	...	...	...	...	29·950	80	·772	...	...	Heavy rain at times.
	8 ,,	...	...	...	...	30·080	82	·897	...	4	
	Midnight	...	...	...	...	·030	82	·847	...	3	
Kerbela	4 A.M.	...	...	...	...	29·980	80	29·722	N.E.	5—6	A.M.—Fresh to strong north-
	8 ,,	...	...	...	...	30·030	81	·769	...	...	east winds with rain squalls,
	Noon	15° 44′ N.	15° 40′ N.	86° 8′ E.	86° 4′ E.	·020	80	·762	...	...	and heavy head sea.
	4 P.M.	...	...	...	...	29·950	81	·689	...	7—8	P.M.—Wind increasing, squalls
	8 ,,	...	...	...	...	30·000	81	·739	...	...	stronger, with continuous
	Midnight	...	...	...	...	·000	79	·745	...	7	heavy rain; current setting
											to the south-west.
Shahjehan	10 A.M.	...	...	...	...	29·960	84	29·951	S.E. by S.	5	10 A.M.—Fresh breeze and over-
	Noon	15° 49′ N.	15° 30′ N.	94° 10′ E.	94° 26′ E.	...	...	...	...	...	cast with incessant rain.
	4 P.M.	...	...	...	...	·900	84·5	·790	S.E. by S.	5	4 P.M. Fresh breeze and over-
											cast; moderate swell from
											south-south-east.
Clan Macdonald	4 A.M.	...	...	...	...	...	...	...	N.E.	7	Daylight, blowing up hard from
	Noon	17° 22′ N.	...	84° 37′ E.	...	29·780	...	29·790	...	...	north-east, sky clear. NOON.
											—Strong breeze and heavy
											squalls with bright light-
											ning.
Coconada	8 A.M.	...	...	...	...	29·750	...	...	N.N.E.	...	Strong breeze and clear. Fresh
	Noon	Towards Kyouk Phyoo.				·760	...	...	S.E.	...	breeze and fine.
	4 P.M.	...	...	...	...	·760	...	...	Variable	...	
	8 ,,	Anchored at Kyouk Phyoo.			...	...	...	...	...	...	
Nith	4 A.M.	...	...	...	...	...	...	...	E.S.E	2	NOON.—Current west 20 mile;
	8 ,,	...	...	...	...	...	...	...	...	...	weather fine and clear. 4 P.M.
	Noon	20° 12′ N.	...	87° 35′ N.	...	29·850?	...	...	E.	6	—Cloudy and squally. 8 P.M.
	4 P.M.	...	...	...	...	...	...	...	E.	...	—Squally with rain, heavy
	8 ,,	...	...	...	...	...	...	...	E.N.E.	...	south-east sea. MIDNIGHT.
	Midnight	...	...	...	...	...	...	...	E.N E.	...	Moderating with heavy swell
											from south-east.
Belfast of Liverpool	1 A.M.	...	...	...	...	29·944	87	29·787	S.E.	3	Signs of a breeze at last in
	4 ,,	...	...	...	...	·912	86	·758	E.	2	a heap of cumulus which
	10½ ,,	...	...	...	...	·990	87	·833	E.N.E.	3	slowly gathered in the east
	Noon	20° 16′ N.	...	87° 15′ E.	...	...	...	...	...	...	quarter; raised the anchor
	2 P.M.	20° 16′ N.	...	87° 12′ E.	...	·928	87	·771	E N.E.	4	at 10 A.M., fresh increas-
	4 ,,	...	...	...	...	·908	86	·754	E.	6—7	ing east-north-east winds.
	6 ,,	...	...	...	...	·908	86	·754	...	...	4 P.M. a squall rapidly
	8 ,,	...	...	...	...	·910	86	·756	E.N.E.	6—7	arose from a bank of cloud
	8½ ,,	...	...	...	...	·920	86	·766	...	...	which had been in the east.
	10 ,,	...	...	...	...	·930	85	·779	E.N.E.	6-7 8	Furled topgallant sail. From
											dusk to midnight, wind blew
											occasionally in pretty hard
											squalls, and was moderate
											between them.
Memnon	4 P.M.	20° 4′ N.	20° 55′ N.	...	...	30·000	...	...	E.	4	Fine and clear.
F. L. V. Star	10 A.M.	Mutla Station		...	...	30·060	85	29·909?	N E. by E	2	Sea smooth.
	4 P.M.	...	...	...	...	29·920	85·5	·767	E.N.E	3	Do.

Vessels.	October 12th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
F. L. V. Meteor	10 A.M.	Eastern Channel Station		...		29·910	87	29·813	E.N.E.	3	Slight sea and swell.
	4 P.M.	...	...	...	...	·850	87	·753	E.	3	
F. L. V. Comet	10 A.M.	Intermediate Station.		...		29·942	85	29·785?	N.E.	4	Sea smooth, swell from south-south-east. At 7-30 A.M. a water spout passed about 11 miles to the north-east of us.
	4 P.M.	...	...	...	...	·928	86	·770	E.	3	

The chart of the 12th October (Plate XX) shows that a barometric depression of slight intensity was now established in the south-west of the Bay, and that cyclonic air motion extended over the whole of the Bay, and the adjacent coast-districts. The depression, as determined from the information of the logs, seems to have been shallow and rather extensive. The centre was probably in lat. 13° N. and long. 85½° E.

The *Erin's Gem*, *City of Agra*, and *Marion King* were at or near the entrance to the Bay on this day. They all experienced dark gloomy weather, with westerly to south-westerly winds, varying in strength from 2 to 6. Frequent squalls, occasionally of terrific force, occurred during the day. Heavy rain also fell during the greater part of the day.

The *Atlantique* was to the north-west of the storm vortex at noon. She had moderate easterly winds, of force 4, during the greater part of the day.

In the northern quadrant were the *Duke of Devonshire* in lat. 15° 35′ N., long. 82° 44′ E.; the *Kerbela* in lat. 15° 44′ N., long. 86° 8′ E.; and the *Clan Macdonald* in lat. 17° 22′ N., and long. 81° 37′ E. These vessels all encountered strong winds increasing in force during the day from 4 to 8. Heavy rain squalls were of frequent occurrence, and the weather was dark, gloomy, and threatening.

At the head of the Bay, the sea was smooth with a slight swell from north-north east. Moderate winds varying in direction between east and north-east prevailed during the day. The weather was, however, now beginning to change. The *Belfast of Liverpool* experienced a squall at 4 P.M., and frequent squalls followed during the night, with intervals of light to moderate winds. A waterspout passed the *Comet* light-vessel early in the morning.

October 13th.—The following table gives land observations for the 13th of October:—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions. 10 A.M.	Wind Directions. 4 P.M.	Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
Colombo	29·933	−·021	SW	?	15·0	221	0·20	...
Galle	29·980	+·048	W	?	12·0	171	0·07	...
Trincomalee	29·850	+·010	WSW	?	15·0	150	...	*b.c.*
Negapatam	29·853	—·072	NW	?	2·0	47	0·15	...
Madras	29·866	—·045	NW	?	5·0	98	1·32	*o.*
Coconada	29·799	?	W	?	13·0	?	0·68	...

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A. M.	4 P. M.				
Vizagapatam	29·784	—·115	NE	NE	5·0	238	0 10	*d.*
Gopalpore	29·839	?	N	N	11·0	?	0·15	*g.*
False Point	29·839	—·070	ENE	E	?	?	0 42	*q.*
Cuttack	29·838	—·077	NE	NE	6·0	286	0·07	*Squally.*
Saugor Island	29·889	—·009	ENE	ENE	6·0	103	0·24	*o.*
Chittagong	29·923	+·002	NE	Calm	2·0	62	...	...
Akyab	29·937	+·023	SE	ESE	3·0	130	...	*b.c.*
Diamond Island	29·962	+·042	ESE	SE	19·0	288	3·12	*o.*
Port Blair	29·948	+·085	SW	SE	6·1	92	0·46	*c.*
Nancowry	29·883	—·007	WSW	WSW	6·5	100	0·14	*o.*
Calcutta	29·902	—·010	E	ESE	3·0	88	...	*b.c.*
Patna	29·962	+·044	ENE	ENE	4·0	222	...	*b.c.*
Allahabad	29·945	+·019	ENE	ENE	1·0	77	...	*b.c.*
Lucknow	29·944	+·023	Calm	Calm	1·0	56	...	...
Lahore	29·931	+·023	E	Calm	1·0	56	...	*b.*
Bombay	29·882	—·057	ESE	NW	10·0	103	...	*b.*
Nagpur	29·873	—·064	E	ENE	4·0	121	...	*b.*

The increase of pressure which commenced on the 12th, continued over the whole of India, except on the coast of the Northern Circars, over which the effect of the advancing cyclonic vortex in diminishing the pressure was greater than the increase over the Continent, due probably to a general vertical oscillatory movement.

In Northern and Western India, the weather was fine with clear skies. Winds were easterly over the whole of the Gangetic Plain, and, with the exception of perhaps the Punjab, Rajputana, Sind, and the Bombay coast, the wind directions over India and the Bay were dependent upon the cyclonic vortex in the Bay. Rain was falling at this time over the whole of the Madras Presidency, Orissa, Southern Bengal, Arrakan, and Pegu, and was heaviest in Pegu. This indicates that the rainfall connected with, and accompanying the cyclonic disturbance, was spread over a very wide area, instead of being concentrated within a narrow compass. The observations, given above, indicate more fully the meteorology of the coast area at this time. The barometer was generally above the average, but there was a local depression in the Northern Circars and Orissa, in front of the advancing cyclone. The depression was small, not exceeding one-eighth of an inch.

Winds had fallen back to their normal strength at Port Blair and Nancowry. The Colombo observations alone indicate the continuance of strong south-westerly winds at the entrance to the Bay. Over the north coasts of the Bay, from Vizagapatam to Diamond Island, winds were everywhere above their normal strength, but were nowhere violent.

The average rainfall in Bengal and Orissa is given below for each district, for the 24 hours preceding 6 P.M., together with the highest fall in each district :—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	1·18	2·25	Bogra	...	...
Cuttack	1·64	3·20	Rajshahye	...	...
Balasore	1·89	4·48	Maldah	...	...
Midnapore	0·44	0·77	Dinagepore	...	...
24-Pergunnahs	0·35	0·90	Rungpore	...	...
Howrah	0·17	0·28	Julpigoree	...	...
Hooghly	0·85	1·08	Cooch Behar	...	...
Burdwan	0·23	0·52	Darjeeling	...	...
Bankoora	0·44	1·27	Purneah	...	...
Beerbhoom	0·08	0·25	Bhagulpore	...	...
Nuddea	0·19	0·53	Durbhanga	...	...
Khoolna	0·27	0·56	Mozufferpur	...	...
Jessore	0·30	0·69	Chumparun	...	...
Moorshedabad	0·18	0·90	Sarun	...	...
Chittagong	0·90	1·76	Shahabad	...	...
Ditto Hill Tracts	0·04	0·08	Gya	...	...
Backergunge	0·10	0·35	Patna	...	...
Noakhally	*Nil.*	*Nil.*	Monghyr	...	...
Furreedpore	0·21	0·49	Sonthal Pergunnahs	...	...
Dacca	0·29	0·84	Hazaribagh	...	...
Tipperah	0·23	0·70	Lohardugga	...	...
Hill Tipperah	*Nil.*	*Nil.*	Manbhoom	0·07	0·07
Mymensingh	*Nil.*	*Nil.*	Singbhoom	0·18	0·18
Pubna	...	...			

Vessels.	October 13th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
City of Agra	4 A.M.	...	...	...	...	29·900	...	29·880	W. S. W.	4	Morning.—Cum. and cir., west-south-west swell. Noon.—Cum. and cir., squally Sea confused. Evening.—Sea moderating; cloud amount 8.
	8 ,,	...	...	...	...	·960	...	·940	W.	2—3	
	Noon	6° 28′ N.	6° 27′ N.	78° 23′ E.	78° 24′ E.	·910	...	·920	W.	2—4	
	4 P.M.	...	...	...	...	·900	...	·880	W. S. W.	4	
	8 ,,	...	...	...	...	·960	...	·940	S. W.	3	
	Midnight	...	...	...	...	·970	...	·950	W.	3—4	
Evin's Gem	5 A.M.	...	...	...	...	29·780	...	29·830	S. W.	4	5 A.M.—Moderate breeze, cloudy and showery. 6 to 9-30 A.M. —Frequent showers of rain. Noon.—Moderate breeze, cloudy and showery. 2 P.M.—Weather fine; steady breeze; 4 P.M.—Weather fine and clear. 9-30 P.M.—Smooth water, fine weather.
	9-30 ,,	...	...	...	...	·860	...	·910	S. S. W.	5	
	Noon	8° 8′ N.	8° 1′ N.	88° 30′ E.	88° 11′ E.	·830	...	·880	W. S. W.	4	
	4 P.M.	...	...	...	...	·750	...	·800	W. S. W.	4	
	9-30 ,,	...	...	...	...	·830	...	·880	S. W.	6	
	Midnight	...	...	...	...	...	...	...	S. W.	...	

Vessels.	October 13th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Marion King	Noon	...	10° 5′ N.	...	84° 54′ E.	...	...	...	S. W.	6	Light rain and squalls with heavy flashes of lightning.
Castore	Noon	12° 02′ N.	12° 38′ N.	85° 25′ E.	84° 10′ E.	29·138	...	...	S. W.	6	Sea high.
Atlantique	4 A.M.	...	14° 45′ N.	...	84° 29′ E.	29·686	...	29·711	N.	3	Cloudy, squally with rain, and stormy winds.
	8 ,,	...	,, 50′ N.	...	,, 45′ E.	·686	...	·711	N. W.	3	
	Noon	14° 43′ N.	,, 57′ N.	84° 48′ E.	85° 04′ E.	·666	...	·691	...	4	
	4 P.M.	...	,, 51′ N.	...	,, 17′ E.	·646	...	·671	W. S. W.	5	Squally stormy winds.
	8 ,,	..	15° 01′	...	,, 40′ E.	·686	...	·711	...	6	Sea very rough.
	Midnight	...	,, 11′	...	86° 13′ E.	·686	...	·711	S. W.	7	
Bancoora	4 A.M.	...	...	...	...	30·030	80	29·852	E. by S.	4	Fresh breeze, overcast, squally with rain, and threatening appearance to south-east.
	8 ,,	...	...	...	...	·140	81	·959	...	4	
	Noon	15° 40′ N.	15° 41′ N.	...	95° 42′ E.	·100	81	·919	E. S. E.	3	
	4 P.M.	...	...	...	...	·030	83	·844	...	...	
Parulia	8 A.M.	Rangoon River		...	...	30·050	...	...	S.	4	8 A.M.—Cloudy weather; very heavy rain. Noon—Cloudy weather to south.
	Noon	16° 01′ N.	...	...	96° 1′ E.	·980	..	...	S.	5	
	4 P.M.	...	...	...	...	·950	...	...	...	4	4 P.M.—Moderate breeze and fine. 8 P.M.—Dark cloudy weather; heavy squalls. Midnight—Light breeze and dark cloudy weather.
	8 ,,	...	...	...	...	·930	..	...	...	3	
	Midnight	Off Algu	ada Light	...	...	·920	...	...	...	2	
Duke of Devonshire	4 A.M.	...	...	...	...	29·750	...	29·770	N. E.	6	A. M. Wind increasing, heavy squalls, much lightning and rain; sky dirty. P.M. Threatening appearance; heavy masses of blue-black clouds on the eastern horizon; heavy sea.
	8 ,,	...	...	...	...	·760	...	·780	...	6	
	Noon	18° 20′ N.	...	84° 55′ E.	...	·760	...	·780	N.	6	
	4 P.M.	...	...	...	...	·700	...	·720	N. E.	6	
	8 ,,	...	...	...	...	·700	...	·720	...	7	
	Midnight	...	...	...	...	·680	...	·700	...	6	
Belfast of Liverpool	1½ A.M.	...	...	...	...	29·880	84	29·742	...	...	Squally in the early morning. Moderate breeze until after sunset, when it again freshened up in squalls; heavy rain. Midnight.—Squally, overcast sky, and rain.
	3 ,,	...	...	...	...	·846	84	·708	E. N. E.	6	
	7½ ,,	...	...	...	...	·886	82	·754	E. N. E. to E.	7	
	9 ,,	...	...	...	...	·896	83	·761	...	...	
	9½ ,,	...	...	...	...	·896	83	·731	E. N. E. to E.	7	The figures 6, 7, 8, from this time represent the usual force of the wind, but the breeze was often interrupted by violent squalls which would easily have dismasted a vessel not prepared to receive them.
	10 ,,	...	...	...	...	·888	83	·753	...	7	
	11½ ,,	...	...	...	...	·850	83	·715	E. S. E.	7	
	Noon	18° 53′ N.	...	87° 51′ E.	...	·832	...	·697	E. S. E.	7	
	1½ P.M.	...	...	...	...	·796	83	·662	S. E.	6—7	
	3 ,,	...	...	...	...	·776	84	·639	S. E.	...	
	4 ,,	...	...	...	...	·774	84	·637	S. E.	6—7	
	6½ ,,	...	...	...	...	·800	84	·662	S. E.	6—7	
	8 ,,	18° 54′ N.	...	87° 51′ E.	...	·842	83	·707	S. E.	6—7	
	8¼ ,,	...	...	...	...	·842	83	·707	S E.	6—7	
	10 ,,	...	...	...	...	·858	83	·725	S. E.	6-7-8	
	11¼ ,,	...	...	...	...	·814	83	·709	S. by E.	7—8	
Coconada	8 A.M.	Kyouk Phyoo		...	...	29·770	...	...	E.	...	Noon, Moderate breeze. Evening. Fine strong breeze and fine but cloudy.
	Noon	18° 55′ N.	...	93° 22′ E.	...	·810	...	...	S.	...	
	4 P.M.	...	...	...	...	·790	...	...	E. S. E.	...	
	8 ,,	Towards	Akyab	...	...	·820	...	...	...	...	
	Midnight	...	...	...	...	·840	...	...	S. S. W.	...	Hard squalls from south-south-west with rain.
Nith	8 A.M.	...	...	...	...	...	...	...	E.	...	A.M.—Heavy squalls with rain. P.M.—High sea, sky threatening, wind hauling to east-south-east; heavy rain from south-east.
	Noon	18° 59′ N.	...	88° 10′ E.	...	29·600 ?	...	...	...	...	
	8 P.M.	...	...	...	...	...	...	...	E. S. E.	5	
	Midnight	...	...	...	...	...	...	...	E. S. E.	...	
Kerbela	4 A.M.	...	...	...	...	29·930	79	29·675	N. E.	7	Strong breeze from north-east with continuous heavy squalls and rain.
	8 ,,	...	...	...	...	30·000	80	·742	to	...	
	Noon	...	19° 4′ N.	...	87° 7′ E.	·000	80	·742	S.	7	
	4 P.M.	...	...	...	...	29·930	78	·677	E. to S.	7	
	8 ,,	...	...	...	...	·980	79	·725	...	5	
	Midnight	...	...	...	...	...	...	...	...	4—3	Midnight.—Rainy weather.
Clan Macdonald	4 A.M.	...	...	...	...	29·740	...	29·750	N.E. by E.	7—8	Very heavy squalls and rain from north-east. Here at 6 P.M. we probably crossed northward of the cyclonic vortex. Heavy squalls, much rain. Raining steadily, with bursts of wind from east by north.
	8 ,,	...	...	...	...	...	...	...	...	...	
	Noon	...	19° 48′ N.	...	86° 44′ E.	·780	...	·790	...	...	
	4 P.M.	...	...	...	...	...	...	...	E. by N.	6—7	
	8 ,,	...	...	...	...	·760	...	·770	...	...	
Undaunted	4 A.M.	...	...	...	...	29·840	...	...	N. E.	6	Lightning and heavy bank of clouds to the south-east.
	8 ,,	...	...	...	...	·840	...	...	N. E.	6	
	Noon	Saugor R	oads.	...	...	·850	...	...	E.	7	
	4 P.M.	...	...	...	...	·850	...	...	E.	6	Very threatening.
	8 ,,	...	...	...	...	·760	...	...	E.	7	
	Midnight	...	...	...	...	·790	...	...	E. N. E.	7	
F. L. V. Star	10 A.M.	Mutla Sta	tion	...	...	29·944	80·9	29·803	E.	7	Sea smooth.
	4 P.M.	...	...	...	...	·824	81	·684	E.	6	
F. L. V. Meteor	10 A.M.	Eastern C	hannel Sta	tion	...	29·890	82	29·805	E. by S.	5	Heavy sea and swell.
	4 P.M.	...	...	...	...	·800	81·5	·715	E. by N.	6	
F. L. V. Comet	10 A.M.	Intermed	iate Statio	n	...	29·970	80	29·820	E.	6—7	A fresh gale during day with passing terrific squalls; wind steady, and heavy cross sea from east and south-east.
	4 P.M.	...	...	...	...	·850	80	·700	E. N. E.	8	

The chart of this day (Plate XX) shows that the cyclone continued to present the appearance of a large shallow depression, giving rise to moderately strong winds, and to frequent severe squalls. The centre of the depression at noon of this day was probably in lat. 16° N. and long. 85½° E., so that it was advancing due north, and its path thus making an acute angle with the coast in front of it. The ships near the entrance to the Bay, including the *Erin's Gem* and *Marion King*, experienced more favourable weather than on the previous day. Moderate to strong south-west winds, with frequent showers, occurred. The *Castore* in lat. 12° 02′ N. had south-west winds of force 6. The *Atlantique*, which was in the south-west quadrant and was nearest to the centre at this time, experienced strong south-west winds of force 5 to 7.

To the north of the centre, were the *Duke of Devonshire* in lat. 18° 20′ N. at noon, the *Belfast of Liverpool*, the *Nith*, and the *Kerbela*. The accounts they give of the weather are very similar, and show that frequent heavy squalls with much rain were now occurring, and that the wind was gradually increasing in force. The *Belfast of Liverpool* passed round from the northern to the eastern quadrant during the day, and encountered violent squalls in the afternoon. The captain notes that the usual force of the wind varied from 6 to 8, but that these strong breezes were interrupted by violent squalls, which would have dismasted a vessel not prepared to receive them.

The light-vessels at the head of the Bay had winds varying from east to north-east during the day. The weather became very threatening, and blew a fresh gale during the day.

October 14th.—The following table gives the more important land observations of the 14th of October:—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·963	+·009	SW	?	14·0	206	0·17	...
Galle	29·957	+·027	SW	?	12·0	171	...	*o.*
Trincomalee	29·876	+·026	SW	?	16·0	160	...	...
Negapatam	29·869	—·056	SW	?	2·0	47	0·11	*o.*
Madras	29·820	—·091	S	?	4·0	78	...	*b. c.*
Coconada	29·759	—·040	W	?	6·0	?	0·30	...
Vizagapatam	29·737	—·162	NW	NW	2·0	95	0·40	*o.*
Gopalpore	29·644	?	NW	W	16·0	?	1·19	*g.*
False Point	29·651	—·258	SE	SE	?	?	4·74	*g.*
Cuttack	29·644	—·271	NNE	NNE	9·0	429	1·03	*q.*
Saugor Island	29·764	—·134	ENE	E	12·0	206	3·11	*o.*
Chittagong	29·902	—·010	SE	SE	2·0	62	0·03	*o.*
Akyab	29·914	0	SSE	SSE	5·0	217	1·29	*b. c.*
Diamond Island	29·961	+·041	SE	SSE	14·0	212	0·30	*Sea rough.*
Port Blair	29·936	+·073	SW	WSW	4·5	68	0·38	*b. v.*
Nancowry	29·939	+·049	WSW	WSW	2·8	43	0·34	*o.*

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Calcutta	29·824	—·088	E	E by S	8·0	235	0·35	*o.*
Patna	29·884	—·034	E	ENE	3 0	167	...	*b. c.*
Allahabad	29·858	—·068	ENE	NE	2·0	154	...	*b. c.*
Lucknow	29·871	—·050	Calm	N	1·0	56	...	...
Lahore	29·874	—·034	NW	W	1·0	56	...	*b.*
Bombay	29·862	—·077	S	W	8·0	82	...	*b.*
Nagpur	29·823	—·114	ENE	NE	4 0	121	...	*b. c.*

The meteorological returns for the whole of India show that the barometer had again commenced to fall; and hence that, probably, another general vertical oscillatory movement of the atmosphere was in progress. The decrease of pressure was least in Southern India, and increased generally northwards. In Bengal it was large in amount and was mainly due to the advancing cyclone, which formed the one special feature of importance in the weather at this time.

The atmospheric circulation over the Bay and the whole of India, exclusive of the Punjab, the western districts of the North-Western Provinces, Sind, and the Bombay coast, was directly dependent upon the continued existence of the cyclonic vortex. In Upper India, the winds were very light and variable, and the weather fine and clear. The sky in the Central Provinces, and the greater part of the Deccan, was more or less clouded.

The chart of the day (Plate XX) shows that the central depression was elliptical-shaped, with its major axis running north-north-west and south-south-east, and that the centre of wind convergence was near the Ganjam coast, and advancing slowly northwards. The gradients were greatest in the northern quadrant.

The winds were now weaker than usual at the southern stations on the coast of the Bay. To the north of Diamond Island and Vizagapatam, they were much stronger than the normal. The increased strength of the winds extended westwards as far as Allahabad and Nagpur.

The sky had become overcast over the whole of Orissa, Bengal, and Behar, except in the immediate neighbourhood of the hills, and rain was falling generally over the Province of Bengal. It was at this time heaviest in Orissa and South-West Bengal.

The following description of the weather at False Point is given by the Light-house-keeper: "Saturday, 14th:—Blowing a strong breeze with squalls, and a heavy overcast sky, and distant thunder and lightning. At 6 A.M., the wind veered round to the south-east, still blowing in heavy squalls. At noon, the squalls became heavier, with very heavy showers of rain. The sea in the Bay was now running very high. At 6 P.M. the wind (still from the south-east) increased to a gale, and blew very hard until midnight, with very heavy gusts, distant thunder and lightning, showers of rain, and very ugly weather. The tide this night was the highest of the year, rising to at least a foot higher than any other tide of the year."

The following table gives the average rainfall for the 24 hours preceding 6 P.M. in each district of the Province of Bengal:—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	1·13	1·60	Bogra	0·07	0·28
Cuttack	1·93	3·64	Rajshahye	0·02	0·03
Balasore	2·69	4·78	Maldah	0·04	0·04
Midnapur	1·34	2·73	Dinagepore	0·01	0·05
24-Pergunnahs	1·05	3·91	Rungpore	0·01	0·02
Howrah	0·60	0·66	Julpigoree	...	...
Hooghly	0·69	1·52	Cooch Behar	...	...
Burdwán	0·19	0·32	Darjeeling	...	...
Bankoora	0·31	0·46	Purneah	0·07	0·22
Beerbhoom	0·35	0·85	Bhagulpur	...	...
Nuddea	0·13	0·69	Durbhanga	...	...
Khoolna	0·67	1·52	Mozufferpur	...	...
Jessore	0·09	0·16	Chumparun	...	...
Moorshedabad	0·24	0·70	Sarun	...	...
Chittagong	0·10	0·20	Shahabad	...	...
Ditto Hill Tracts	0·07	0·08	Gya	0·06	0·22
Backergunge	1·81	3·20	Patna	...	...
Noakhally	1·55	2·78	Monghyr	0·03	0·10
Furreedpore	0·09	0·28	Sonthal Pergunnahs	0·38	1·18
Dacca	1·00	1·70	Hazaribagh	0·36	0·69
Tipperah	0·59	1·15	Lohardugga	0·35	0·60
Hill Tipperah	0·86	0·86	Manbhoom	0·30	0·36
Mymensingh	0·02	0·09	Singbhoom	0·08	0·08
Pubna	...	...			

Vessels.	October 14th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
City of Agra	4 A.M.	...	...	...	...	29·900	82	29·880	W. S. W.	3	Morning.—Squally, cloudy.
	8 ,,	...	...	...	...	·940	82	·920	W.	3	Noon.—Sea 3, from west-south-west, cloud 7, same weather. 4 P.M.—Cloud 5. Sea 3. 8 P.M.—Clear, sea 3. Midnight.—Cloud 6, sea 3.
	Noon	7° 31′ N.	7° 27′ N.	74° 49′ E.	75° 10′ E.	·940	82	·920	...	2—3	
	4 P.M.	...	...	...	...	·900	82	·880	...	4	
	8 ,,	...	...	...	...	·940	82	·920	...	3	
	Midnight	...	...	...	...	·980	82	·960	...	3	
City of Canterbury	4 A.M.	...	8° 18′ N.	...	69° 32′ E.	29·900	79	29·925	W.	5	Morning.—Moderate sea, cloudy, fine weather. Noon.—Slight sea, cloudy, and fine weather. Evening.—Slight sea, cloudy, with occasional showers.
	8 ,,	...	8° 25′ N.	...	68° 57′ E.	·970	81	·995	W.	4	
	Noon	8° 43′ N.	...	68° 20′ E.	...	·960	81	·985	W.	5	
	4 P.M.	...	8° 53′ N.	...	67° 45′ E.	·880	80	·905	W.	4	
	8 ,,	...	9° 03′ N.	...	67° 10′ E.	·940	82	·965	W. by N.	4	
	Midnight	...	9° 13′ N.	...	66° 35′ E.	·960	80	·985	W. by N.	5	

Vessels.	October 14th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Erin's Gem	3-30 A.M.	...	...	...	...	29·780	...	29·830	S. W.	5	A.M. very fine weather. Hazy, fine, and smooth water throughout the day.
	9-30 ,,	...	...	...	...	·850	...	·900	S. S. W.	4	
	Noon	11° 8′ N.	11° 2′ N.	88° 16′ E.	89° 16′ E.	·820	...	·870	S. S. W.	4	
	4 P.M.	...	...	...	...	·790	...	·810	W.	4	
	9-30 P.M.	...	...	...	...	·800	...	·850	S. W.	4	
	Midnight	...	...	...	...	...	...	...	...	4	
Marion King	Noon	...	13° 25′ N.	...	86° 5′ E.	...	...	...	S. S. W.	6	Heavy lightning, steady breeze, and water smooth.
Castore	4 A.M.	...	...	...	...	30·079	...	...	...	...	Sea high.
	8 ,,	...	...	...	...	·197	...	...	...	...	
	Noon	15° 40′ N.	15° 33′ N.	86° 37′ E.	86° 25′ E.	·197	...	...	S. W.	7	
	4 P.M.	...	...	...	...	·001	...	...	...	...	
	8 ,,	...	...	...	...	·040	...	...	...	...	
	Midnight	...	...	...	...	·020	...	...	...	...	
Atlantique	4 A.M.	...	15° 21′ N.	...	88° 47′ E	29·666	...	29·691	S. W.	7	A.M.—Squally, weather threatening. Sea very high. Heavy rain. P.M. Squalls of great violence. Sea very high.
	8 ,,	...	15° 32′ N.	...	87° 21′ E.	·725	...	·750	...	7	
	Noon	15° 52′ N.	15° 43′ N.	88° 7′ E.	87° 57′ E.	·686	...	·711	...	8	
	4 P.M.	16° 16′ N.	16° 16′ N.	...	84° 34′ E.	·646	...	·671	S.	8	
	8 ,,	...	16° 38′ N.	...	86° 1′ E.	·686	...	·711	...	8	
	Midnight	...	16° 58′ N.	...	86° 24′ E.	·725	...	·750	S. S. W.	8	
Coconada	4 A.M.	Towards Algnada.				29·820	...	...	S. S. E.	...	A.M.—Fresh head breeze, heavy clouds. Noon.—Squally thick rainy weather. Evening.—Moderate breeze and cloudy.
	8 ,,	...	...	...	...	·820	...	...	...	...	
	Noon	...	15° 56′ N.	...	94° 07′ E.	·820	...	...	S.	...	
	4 P.M.	Off Cape Negrais.				·780	...	...	S.	...	
	8 ,,	Off Alguada.				·800	...	...	...	...	
	Midnight	Towards Krishna.				·840	...	...	...	...	
Purulia	4 A.M.	...	...	...	...	...	...	...	S. E.	4	8 A.M.—Fine weather, cloudy, rain at intervals. Noon.—Overcast with occasional rain. 4 P.M.—Overcast, south-west swell. 8 P.M.—Overcast. Squally and rain.
	8 ,,	...	...	...	...	29·900	29·850	...	S. W.	4	
	Noon	...	16° 53′ N.	92° 47′ E.	92° 46′ E.	·920	...	...	S. E.	4	
	4 P.M.	...	...	...	...	·910	...	...	S. S. W.	4	
	8 ,,	...	...	...	...	·880	...	...	...	4	
	Midnight	...	...	...	...	·830	...	...	...	5	
Belfast of Liverpool	5½ A.M.	...	...	...	...	29·780	82	29·648	...	...	Squally with heavy rain showers throughout these 24 hours. Much lightning during the dark hours. Ship standing to the eastward.
	8 ,,	...	...	...	...	·832	82	700	S. by E.	sqlly.	
	8½ ,,	...	...	...	...	·850	82	718	S. by E.	and	
	10 ,,	...	...	...	...	·850	82	718	S.toS.S.W.	force	
	Noon	...	19° 47′ N.	...	88° 51′ E.	·820	82	668	S.toS.S.W.	vble.	
	1½ P.M.	...	...	...	...	·794	82	662	S.	...	
	2-50 ,,	...	...	...	...	·764	82	622	...	...	
	4 ,,	...	...	...	...	·750	81	621	S. by W.	vble.	
	7½ ,,	...	...	...	...	·772	82	640	S.	8 to 9	
	8 ,,	...	...	...	...	·772	82	640	S.	7-8-9	
	9½ ,,	...	...	...	...	·792	82	660	S.	8 to 9	
	10 ,,	...	...	...	...	·806	82	674	...	...	
	Midnight	...	...	...	...	·784	82	652	S.	8	
Duke of Devonshire	4 A.M.	...	...	...	...	29·650	...	...	N. E.	6	Wind from north-east, strong breeze to strong gale. Heavy south-east swell, hard squalls, constant rain, dense masses of blue-black clouds on the horizon.
	8 ,,	...	...	...	...	·650	...	...	...	6	
	Noon	19° 49′ N.	...	86° 25′ E.	...	·600	...	...	...	6	
	4 P.M.	...	...	...	...	·570	...	...	E. N. E.	7	
	8 ,,	...	...	...	...	·510	...	...	E.	9	
	Midnight	...	...	...	...	·550	...	...	S. E.	9	
Nith	8 A.M.	...	...	...	...	...	...	...	S. E.	...	Current west-south-west 48 miles. Heavy gale and terrific squalls. Heavy sea.
	Noon	...	20° 1′ N.	...	89° 16′ E.	29·520	...	...	...	...	
	4 P.M.	...	...	...	...	...	...	...	S. S. E.	...	
	8 ,,	...	...	...	...	...	...	...	S. S. E.	...	
Clan Macdonald	4 A.M.	...	...	...	...	29·680	...	...	E. N. E.	6—7	Weather dark and rainy, with strong current. 9 P.M.—Had a hard squall amounting to a gale. Rain coming down in torrents.
	Noon	Eastern Channel.				·700	...	...	...	...	
	4 P.M.	Anchored at Saugor.				...	...	...	E. to S. E.	7—8	
	8 ,,	...	...	...	...	·720	...	...	...	...	
	Midnight	...	...	...	...	...	...	...	E. S. E.	7—8	
Undaunted	4 A.M.	...	...	...	...	29·790	...	...	E. N. E.	7	8 A.M.—Threatening appearance. Noon, heavy rain squalls. 4 P.M.—Very squally appearance.
	8 ,,	...	...	...	...	·790	...	...	E. N. E.	7	
	Noon	Black's Point River Hooghly.			...	·760	...	...	E. N. E.	7	
	4 P.M.	...	...	...	...	·700	...	...	E. N. E.	7	
	8 ,,	...	...	...	...	·700	...	...	E. N. E.	7	
	Midnight	...	...	...	...	·700	...	...	E. by S.	8	
F. L. V. Star	10 A.M.	Mutla.		...	...	29·872	78·5	29·739	E. S. E.	5	Sea rough, heavy squalls, and rain. Sea increasing.
	4 P.M.	...	...	...	...	·710	86	·558	E. S. E.	7	
F. L. V. Meteor	10 A.M.	Eastern Channel.				29·810	79	29·736	S. E.	5	Heavy sea and swell.
	4 P.M.	...	...	...	...	·672	80	·596	E. S. E.	6	
F. L. V. Comet	10 A.M.	Intermediate station.				29·870	78	29·736	E.	6	Strong gale throughout the day and cross sea.
	4 P.M.	...	...	...	...	·700	80	·563	E.	8	
Navarino	Noon	15 miles above Sangor Island.				29·800	...	...	S. E.	4	From noon till midnight, dark threatening weather with heavy rain, and cyclonic appearance from 3 P.M. till midnight.
	4 P.M.	...	...	...	...	·740	...	...	...	1—3	
	8 ,,	...	...	...	...	·760	...	...	E. N. E.	7	
	Midnight	...	...	...	...	·750	...	...	...	...	

The cyclonic depression was now at its greatest development in the Bay, and was approaching the Ganjam coast. The chart drawn from the land and sea observations

indicates that its centre was in about lat. 19° N. and long. 85½° E. The depression was elliptical-shaped, its longest axis being in a north-north-west and south-south-east direction. The central depression apparently covered a considerable area over which the differences of pressure were very small, whilst the gradients were steepest in the north-east direction or in the line of its future march.

In the south of the Bay, the weather had improved very considerably. The *Erin's Gem*, in lat. 11° N. and long. 89° E., had fine weather with a smooth sea. Further north, the *Marion King*, in lat. 13° 25′ N., long. 86° 5′ E., had a strong south-south-west breeze (force 6) and smooth water. The *Atlantique*, in lat. 16° N. and long. 88° E., was much nearer to the centre, and experienced strong south to south-west winds, of force 7 to 8. Several ships were near the head of the Bay, and give a full account of the weather there. The *Belfast of Liverpool*, to the east of the central depression, in lat. 20° N. and long. 89° E., had strong but variable southerly winds, of force 7 to 9, with frequent squalls and heavy rain showers. The *Duke of Devonshire*, in the same latitude, but in long. 86° 25′ E. had the wind from the north-east. It blew a strong gale with hard squalls and constant rain. The *Nith* and *Clan Macdonald* furnish similar evidence of the weather in the same part of the Bay. The light vessels, the *Meteor* and *Comet*, give the force of the wind as increasing during the day from 5 to 8. The weather over the north-west of the Bay was of the usual cyclonic character. The winds, although blowing in very strong gusts, do not seem ever to have attained to hurricane force.

October 15th.—The following table gives the more important land observations for the 15th of October :—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·950	—·004	S. W.	?	12·0	176	0·04	...
Galle	29 950	?	W. N. W.	?	10·0	143	0·21	...
Trincomalee	29·856	+·016	SW	?	19·0	190	...	...
Negapatam	29·877	—·048	SSW	?	3·0	70	...	*Sultry.*
Madras	29·829	—·082	SSW	?	5·0	98	2·03	*o.*
Vizagapatam	29·709	—·190	W	SW	3·0	143	0·50	*o.*
Gopalpur	29·612	?	SW	SW	15·0	...	1·40	...
False Point	29·585	—·324	SW	SW	...	...	7·70	*q.*
Cuttack	29 525	—·390	SSW	WSW	11·0	524	4·07	*o.*
Saugor Island	29·609	—·289	SSE	S	16 0	276	4·01	*d.*
Chittagong	29·862	—·059	NNE	NE	4·0	124	0·20	*Threatening.*
Akyab	29·885	—·029	SE	S	5·0	217	0·30	*b. c.*
Diamond Island	29·920	?	SE	SSW	7·0	106	...	*Sea falling.*
Port Blair	29·912	+·049	WSW	WSW	4·6	70	...	*c.*
Nancowry	29·916	+·026	WSW	WSW	4·8	74	...	*c.*

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Calcutta	29·689	—·223	E	SE	12·0	353	5·53	*o.*
Patna	29·831	—·087	E	E	6·0	334	...	*o.*
Allahabad	29·804	—·122	NE	NE	?	...	...	*b. c.*
Lucknow	29·836	—·085	NNE	NE	1·0	56	...	*c.*
Lahore	29·824	—·084	SE	N	1·0	56	...	...
Bombay	29·863	—·076	S	W	5·0	52	...	*b. c.*
Nagpur	29·781	—·156	NE	NNE	5·0	152	0·02	*b, c.*

The fall of the barometer had continued during the previous 24 hours over the whole of India, with the exception of a few stations in the extreme south. It was largest, as on the previous day, in Orissa and Bengal. The cyclonic vortex continued to be the only marked feature in the meteorology of India at this time. The winds everywhere, except in the Punjab and on the Bombay coast, indicated that they formed part of the general cyclonic circulation due to the depression in Orissa and Bengal.

The sky was clear in the Punjab, the western districts of the North-Western Provinces, Rajputana, and Sind, and more or less clouded elsewhere.

The comparison of the 10 A.M. observations shows that the depression continued to present the same characteristic features as on the previous day. It was a large shallow elliptical depression stretching in its longest direction from False Point to Sambalpur. Its axis thus ran west-north-west and east-south-east. The lowest reading of the barometer at 10 A.M. was observed at Cuttack, and was ·39″ below the average 10 A.M. pressure for the month. It is hence probable that at this time the barometric depression did not exceed half an inch.

The bi-hourly observations taken at False Point indicate that the centre crossed the Orissa coast to the south of that station, and probably near Pooree, late on the evening of the 14th, and that it advanced towards Cuttack. The centre was apparently in the neighbourhood of, and to the north-west of, Cuttack at 10 A.M., as judged by the wind directions. The weather in Orissa is described as follows by Mr. Workman, Light-house, keeper, False Point: "Early on the morning of the 15th, the gale was blowing as furiously as ever, and the weather had the same unpleasant appearance until 3 A.M., when it began to moderate. The squalls were then less frequent and fierce than before. At 4 A.M. the wind veered round to south, blowing a fresh breeze with an overcast sky. At 6 A.M. the wind was at south-west, and blowing strongly with smart squalls, but the sky began to clear up, and patches of blue sky began to be visible. It continued to blow strongly from the south-west with smart squalls during the day. At 8 P.M. we had a very severe squall from the south-west, with heavy thunder and lightning. It lasted for only a few minutes; but during that interval it blew more strongly than in any of the squalls during the gale, and made the Light-house shake from top to bottom."

The character and distribution of the rainfall in the Province of Bengal for the 24 hours preceding 6 P.M. is fully shown in the following table :—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	1·76	4·54	Bogra	0·49	0·85
Cuttack	1·85	3·30	Rajshahye	0·58	0·96
Balasore	1·67	4·44	Maldah	0·44	0·44
Midnapur	4·52	7·80	Dinagepore	2·38	4·52
24-Pergunnahs	3·56	7·30	Rungpore	1·49	4·85
Howrah	3·54	4·07	Julpigoree	0·11	0·22
Hooghly	3·63	4·71	Cooch Behar	0·33	0·41
Burdwan	2·55	3·70	Darjeeling	0·02	0·04
Bankoora	2·73	4·00	Purneah	1·04	2·70
Beerbhoom	2·89	4·10	Bhagulpore	0·46	0·70
Nuddea	2·28	3·59	Durbhanga	0·40	1·00
Khoolna	4·50	5·50	Mozufferpore	0·31	0·80
Jessore	2·22	3·68	Chumparun	...	...
Moorshedabad	2·87	4·82	Sarun	0·13	0·16
Chittagong	0·39	0·72	Shahabad	0·34	0·95
Ditto Hill Tracts	0·12	0·20	Gya	0·69	1·00
Backergunge	3·57	5·10	Patna	0·27	0·69
Noakhally	1·04	1·38	Monghyr	0·76	1·55
Furreedpore	1·84	3·12	Sonthal Pergunnahs	1·38	3·70
Dacca	1·13	1·54	Hazaribagh	1·63	2·32
Tipperah	0·86	1·20	Lohardugga	1·49	2·72
Hill Tipperah	0·30	0·30	Manbhoom	2·18	2·65
Mymensingh	1·79	4·12	Singbhoom	2·35	2·35
Pubna	0·73	1·30			

Vessels.	October 15th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
The Bruce	Noon	6° 07′ S.	6° 09′ S.	84° 32′ E.	84° 32′ E.	...	...	...	S.	2	Light airs and hot sultry weather.
Erin's Gem	3-30 A.M.	...	...	...	...	29·750	...	29·800	S. S. W.	3	Cloudy; thick haze; overcast; heavy swell. Noon—Moderate breeze. Evening—Cum. and cir. round the horizon.
	9-30 ,,	...	...	...	...	·840	...	·890	S.	3	
	Noon	13° 21′ N.	13° 35′ N.	89° 50′ E.	89° 47′ E.	·800	...	·850	S. W.	3	
	4 P.M.	...	...	...	...	·700	...	·750	S.	3	
	9-30 ,,	...	...	...	...	·750	...	·800	S.	3	
	Midnight	...	...	...	...	...	...	...	...	...	
Shahjehan	10 A.M.	...	15° 50′ N.	...	93° 55′ E.	30·000	83	29·894	S. W.	2	10 A.M.—Gentle breeze and fine clear weather. 4 P.M.—Moderate west-south-west swell.
	Noon.	16° 08′ N.	16° 5′ N.	93° 4′ E.	93° 37′ E.	...	...	...	...	...	
	4 P.M.	...	16° 38′ N.	...	93° 10′ E.	29·910	84	801	W. by S.	3	

Vessels.	October 15th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Marion King	Noon	...	16° 53′ N.	...	86° 48′ E.	...	...	...	S. S. W.	6	Strong breeze with rain squalls, and heavy overcast sky to north-west.
Atlantique	4 A.M.	...	17° 19′ N.	...	89° 48′ E.	29·764	...	29·789	S.	8	Squalls of great violence; sea very high.
	8 ,,	...	17° 41′ N.	...	90° 16′ E.	·764	...	·789	S.	8	
	Noon	18° 04′ N.	18° 08′ N.	91° 10′ E.	90° 47′ E.	·764	...	·789	S. S. E.	8	
	4 P.M.	...	18° 30′ N.	...	91° 11′ E.	·725	...	·750	S. S. W.	8	Sky clouded; violent squall.
	8 ,,	...	18° 57′ N.	...	90° 45′ E.	·764	...	·789	S. S. W.	7	Sea high.
	Midnight	...	19° 28′ N.	...	90° 12′ E.	·686	...	·711	S. S. W.	8	
Castore	4 A.M.	...	18° 3′ N.	...	...	29·941	...	...	...	...	Squally; sea very high.
	8 ,,	...	...	...	...	30·001	...	...	...	...	
	Noon	...	18° 54′ N.	...	87° 00′ E.	29·961	...	...	S.	8	
	4 P.M.	...	...	...	...	·902	...	...	...	...	
	8 ,,	...	...	...	...	·941	...	...	...	...	
	Midnight	...	...	...	...	·922	...	...	...	...	
Purulia	4 A.M.	...	...	...	...	29·730	89	29·680	S. S. W.	5	4 A.M.—Overcast sky, heavy squalls; moderate beam sea; 8 A.M.—Dark, cloudy weather, heavy squalls. Noon; terrific squalls and very heavy rain, heavy south-west swell; 8 P.M.—Heavy sea from south.
	8 ,,	...	...	...	...	·770	88	720	...	5	
	Noon	...	19° 35′ N.	...	89° 50′ E.	·790	84	740	...	5	
	4 P.M.	...	...	...	...	·760	88	710	...	5	
	8 ,,	...	...	...	...	·700	86	650	...	6	
	Midnight	Off Mutla Light		...	...	·660	87	610	...	6	
Nith	8 A.M.	...	...	...	...	...	...	...	S.	...	Noon—Heavy gale, thunder and lightning. Night—heavys qualls, and pitch-dark all around.
	Noon	...	20° 5′ N.	...	88° 16′ E.	29·480?	...	29,680?	S.	...	
	Midnight	...	...	...	...	...	...	...	S.	...	
Belfast of Liverpool	4 A.M.	...	...	...	...	29·740	82	·608	S.	8	At 10 A.M. a violent squall from south-west. We had occasionally strong squalls, and heavy gusts, during these 24 hours. A confused sea running between south and south-east; ship standing east-south-eastwards at throughout.
	5½ ,,	...	...	...	...	·750	82	·618	...	...	
	8 ,,	...	...	...	...	·784	82	·652	S.	7-8-9	
	9½ ,,	...	...	...	...	·810	82	·678	...	...	
	9¾ ,,	...	...	...	...	·836	82	·704	S. W.	9—10	
	10 ,,	...	...	...	...	·844	82	·712	...	...	
	Noon	...	20° 16′ N.	...	89° 18′ E.	...	...	...	...	...	
	1 P.M.	...	...	...	...	·768	81	·639	S.	7-8-9	
	2 ,,	...	...	...	...	·740	81	·611	...	...	
	3¾ ,,	...	20° 16′ N.	...	89° 19′ E.	·728	82	·595	S.	7—8	
	4 ,,	...	...	...	...	·728	82	·596	S.	7—8	
	5½ ,,	...	...	...	...	·732	82	·600	...	...	
	6¾ ,,	...	...	...	...	·750	82	·618	S.	7—8	
	9¾ ,,	...	...	...	...	·830	83	·695	...	Variable.	
	Midnight	...	...	...	...	·818	83	...	S.	7—8	
Duke of Devonshire	4 A.M.	...	...	...	...	29·500	82	...	S.	9	Strong gale; squalls decreasing; heavy sea from south; much rain; sky still dirty.
	8 ,,	...	...	...	...	·540	82	...	S. S. W.	8	
	Noon	20° 54′ N.	...	...	88° 0′ E.	·540	82	...	...	8	
	4 P.M.	...	...	...	...	·540	84	...	...	8	
	8 ,,	...	...	...	...	·550	84	...	...	8	
	Midnight	...	...	...	...	·550	84	...	...	8	
Tibre	4 A.M.	...	...	...	...	29·674	...	29·624	E. S. E.	6	Bad weather; squalls with very heavy rain; sea very rough.
	8 ,,	Off Saugor	...	...	...	·666	...	·616	S. E.	7	
	Noon	...	...	...	...	·646	...	·596	S. S. E.	6	
	4 P.M.	...	...	...	...	·591	...	·541	S.	7	
	8 ,,	...	...	...	...	·666	...	·616	S. by W.	6	
	Midnight	...	...	...	...	·705	...	·655	S. S. W.	6	
Undaunted	4 A.M.	...	...	...	...	29·600	...	...	S. S. E.	8	Strong south-east winds with heavy rain. Very threatening appearance.
	8 ,,	...	...	...	...	·610	...	...	S. S. E.	8	
	Noon	Black's Point		...	...	·610	...	...	S. S. E.	8	
	4 P.M.	River Hooghly		...	...	·560	...	...	S. E.	7	
	8 ,,	...	...	...	...	·610	...	...	S.	7	
	Midnight	...	...	...	...	·610	...	...	S.	7	
Clan Macdonald	4 A.M.	...	...	...	...	29·700	...	...	E. & S.	6—7	Wind not quite so hard; heavy rain; proceeding up the river from Saugor. At Calcutta weather clear.
	Noon	...	...	...	...	·720	...	...	E. S. E.	6—7	
	8 P.M.	...	...	...	...	·740	...	...	...	...	
F. L. V. Star	10 A.M.	Mutla	...	...	...	29·710	80	29·573	S. E. by S.	10	Sea very heavy; heavy rain; sea increasing and breaking over the vessel. Much rain.
	4 P.M.	...	...	...	...	·570	80	·434	S. by E.	8	
F. L. V. Meteor	10 A.M.	Eastern Channel		...	...	29·660	80	29·574	S.	8	Heavy sea and swell.
	4 P.M.	...	...	...	...	·650?	80	...	S.	8	
F. L. V. Comet	10 A.M.	Intermediate Station		...	...	29·704	79	29·570	E. S. E.	9	Blowing a strong gale throughout the day; high cross confused sea.
	4 P.M.	...	...	...	...	·570	82	·429	S.	9	
Navarino	4 A.M.	...	...	...	...	29·670	...	29·620	E. N. E.	7—8	4 A.M. heavy squalls and rain; 8 A.M. threatening weather; Noon constant heavy rain; 4 P.M. squally with heavy rain; 8 P.M. hard squalls of wind and rain.
	8 ,,	...	...	...	...	·710	...	·660	E.	5—8	
	Noon	Diamond Harbour		...	...	·660	...	·610	E. by S.	5—7	
	4 P.M.	...	...	...	...	·600	...	·550	S. E. by E.	5—7	
	8 ,,	...	...	...	...	·640	...	·590	S.	6	
	Midnight	...	...	...	...	·600	...	·550	S.	6	
Ellora	Noon	Garden Reach		...	...	29·710	...	...	S. E.	4	Wind hauling from east to south, with hard squalls accompanied by heavy rain. Squalls became more violent towards midnight.
	4 P.M.	...	...	...	...	·600	...	...	S. E.	5	
	8 ,,	Calpee Roads		...	...	·620	...	...	S. S. E.	6	
	Midnight	...	...	...	...	·610	...	...	S. S. E.	8	

As the vortex had crossed the Orissa coast early in the morning of the 15th, the ships at the head of the Bay were all in the eastern or southern quadrant of the cyclone; the quadrants in which winds are usually strongest, and squalls most violent in the smaller cyclones on the Bay.

At the head of the Bay there was a large number of vessels, some of which had been lying off the Sandheads for some days, waiting to enter the river, and others brought up by the southerly winds in the rear of the storm. The *Belfast of Liverpool*, in lat. 20° 16′ N. and long. 89° 18′ E. at noon, had southerly winds, of force 7 to 10, during the day. A violent squall passed over the ship at 10 A.M., and strong squalls, and heavy gusts, occurred at intervals. The *Purulia* in lat. 19° 35′ N. and long. 89° 50′ E. at noon had terrific squalls and very heavy rain. The *Duke of Devonshire*, *Tibre*, and *Clan Macdonald* give similar evidence of the amount of rain, strength of wind, and confused sea running at this time. The light-vessels at the mouth of the Hooghly estimate the force of the wind as varying from 8 to 10 during the day.

In the centre of the Bay were the *Marion King*, *Shahjehan*, and *Atlantique*. They experienced strong breezes with rain and squalls. To the south of lat. 14°, the weather had now moderated very considerably. South-westerly winds, of force 2 to 4, were experienced by the *Erin's Gem* in lat. 13° 21′ N. and long. 89° 50′ E.

To the south of the Equator, in lat. 6° S. and long 84° 32′ E., the ship *Bruce* had light southerly airs and hot sultry weather.

October 16th.—The following table gives observations taken at the more important land observatories on the 16th October:—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·870	—·084	SW	?	9·0	132	0·16	...
Galle	29·920	+·038	NW	?	12·0	171	0·02	*b.*
Trincomalee	29·830	—·010	SW	?	23·0	230	...	...
Negapatam	29·834	—·091	W	?	3·0	70	0·07	...
Madras	29·821	—·090	SW	?	6·0	118	...	*b. c.*
Coconada	29·743	?	WSW	?	8·0	?	...	*b. c.*
Vizagapatam	29·722	—·177	W	S by W	5·0	238	...	*b. c.*
Gopalpore	29·699	?	W	S	5·0	?	...	...
False Point	29·704	—·205	WSW	SW	?	?	0·71	*c.*
Cuttack	29·683	—·232	SW	SW	8·0	380	0·12	*b. c.*
Saugor Island	29·675	—·223	SSW	S	24·0	412	1·41	...
Chittagong	29·818	—·103	ESE	ESE	7·0	218	0·01	*o.*
Akyab	29·884	—·030	S	S	5·0	217	...	*b. c.*
Diamond Island	29·927	+·007	ENE	S	4·0	61	...	...
Port Blair	29·918	+·055	NNW	WSW	7·9	120	...	*c.*
Nancowry	29·889	—·001	WSW	WSW	3·6	55	0·28	*o. u.*

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Calcutta	29·660	—·252	SSW	SSW	11·0	324	2·80	*g.*
Burdwan	29·623	—·300	ENE	ENE	8·0	364	3·20	...
Patna	29·772	—·146	NE	NE	12·0	668	0·21	*Raining.*
Allahabad	29·785	—·141	ESE	Calm	?	...	...	*b. c.*
Lucknow	29·764	—·157	SSE	WSW	1·0	56	...	...
Lahore	29·772	—·136	W	Calm	1·0	56	...	*b.*
Bombay	29·878	—·061	SE	WNW	7·0	72	...	*c.*
Nagpore	29·771	—·166	NNE	N	5·0	152	...	*b. c.*

The barometer continued to fall over nearly the whole of India. The fall was small in the south of India, and increased northwards, and was greatest in Upper India. In Bengal and Orissa, the changes that were observed were mainly due to the motion of the cyclonic whirl. The depression was now becoming more diffused, and filling up. The central area was larger than on the 15th, and occupied the Sonthal Pergunnahs, Chutia Nagpur, and the adjacent districts of Orissa, Bengal, and Behar. The depression was still approximately elliptical in form, but its major axis was longer, as compared with its minor, than on the previous day. The axis had also been deflected through a right angle during the preceding 24 hours, and now lay from north-east to south-west. The depression was less clearly defined than on the 14th and 15th, and it is not possible from the observations to determine with any exactness the centre of wind convergence. It was probably in the Midnapore district of South-west Bengal. The gradients were steepest in the north-east quadrant, or in the direction of the line of advance of the cyclone.

The cyclonic circulation extended over nearly the same limits as on the preceding day, but was rapidly decreasing in intensity. During the preceding 24 hours the average wind velocity in Bengal, Orissa, and Behar, had been from two to eight times its normal amount. Beyond Allahabad, winds were exceedingly light, and calms were recorded at many stations. They had not yet in fact settled down into their normal cold-weather direction, westerly, in the Punjab and Upper North-Western Provinces. The sky was overcast in Bengal, Behar, and Orissa, and clear over the greater part of the North-Western Provinces, the Punjab, Rajputana, Sind, and Central India.

In Orissa, the winds were strong in the morning from the south-west. The sky was overcast, and the weather dark and gloomy. The winds began to moderate about midday, and rapidly diminished in strength; so that, after sunset, light south-westerly airs, with fine weather, and partially clouded skies, prevailed. In South-West Bengal, the sky was densely laden with clouds, the wind was strong from the south-west, and blew in occasional gusts of moderate severity, with much rain. The weather there, as in Orissa, began to clear up rapidly in the afternoon.

The rainfall which was now accompanying the cylone, was almost entirely confined to Bengal, Chutia Nagpur, Orissa, and Assam. The following return gives the complete

data showing the distribution and character of the rainfall for the 24 hours preceding 6 P.M. :—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	0·01	0·03	Bogra	6·68	7·82
Cuttack	0·14	0·50	Rajshahye	4·76	5·00
Balasore	0·03	0·16	Maldah	3·63	3·63
Midnapore	1·16	2·60	Dinagepore	3·04	4·76
24-Pergunnahs	2·91	7·70	Rungpore	4·69	8·88
Howrah	2·10	2·20	Julpigoree	4·61	5·75
Hooghly	0·89	1·66	Cooch Behar	4·97	6·12
Burdwan	2·65	5·52	Darjeeling	6·46	7·59
Baukoora	1·05	2·04	Purneah	2·84	3·35
Beerbhoom	2·07	3·35	Bhagulpore	2·46	3·05
Nuddeah	3·00	4·46	Durbhanga	0·27	0·63
Khoolna	3·83	6·90	Mozufferpore	0·54	1·19
Jessore	1·79	2·91	Chumparun	.....	.....
Moorshedabad	2·76	3·69	Sarun	0·01	0·02
Chittagong	0·06	0·12	Shahabad	0·23	0·79
Ditto Hill Tracts	.....	.....	Gya	1·41	2·20
Backergunge	1·74	3·08	Patna	1·30	2·29
Noakhally	0·97	1·22	Monghyr	1·45	1·84
Furreedpore	5·88	9·87	Sonthal Pergunnahs	1·25	2·09
Dacca	3·71	5·50	Hazaribagh	0·78	1·50
Tipperah	1·38	2·10	Lohardugga	0·49	0·73
Hill Tipperah	0·70	0·70	Manbhoom	0·72	0·76
Mymensingh	4·27	9·72	Singbhoom	0·94	0·94
Pubna	6·53	8·90			

Vessels.	October 16th.	Latitude.		Longitude.		Barometer.		Probable reduced Barometer.	Winds.		Remarks.
	Hour.	Obsd.	D. R.	Obsd.	D. R.	Height.	Attd. Therm.		Dir.	Force.	
The Bruce	Noon	5° 23′ S.	5° 20′ S.	84° 31′ E.	84° 31′ E.	...	...	...	N. E.	2	Light breeze and hot sultry weather.
Erin's Gem	3-30 A.M.	...	...	...	...	29·710	...	29·760	S. S. W.	5	A.M.—Moderate breeze from south-south-west; frequent flashes of lightning in north-west quarter from 2-25 to 3-30 A.M. 3 A.M.—Heard a distant rumbling of thunder in the north-west quarter; Noon—Weather very fine; a dense haze; swell south-west to south, confused but small. Midnight—Light breeze from south-south-east.
	9-30 „	...	...	...	...	·800	...	·850	S. S. E. to S. S. W.	4	
	Noon	15° 31′ N.	15° 34′ N.	90° 10′ E.	90° 3′ E.	·780	...	·830	S.	4	
	4 P.M.	...	...	...	...	·720	...	·770	S. by W.	4	
	8 „	...	...	...	...	·820	...	·870	S. S. W.	4	
	Midnight	...	...	...	...	...	...	...	S. S. E.	3	

Vessels.	October 16th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Hutton	Noon	16° 40′ N.	..	92° 15′ E.	...	29·800	...	29·850	S. S. W.	4	Moderate sea rolling from south-west; lightning to south-west; cloudy.
Bancoora	4 A.M.	...	...	...	...	29·980	82	29·807	N. W.	...	Light breeze and fine; current to west, one knot per hour.
	8 ,,	...	...	...	...	30·030	83	·844	Unsteady	...	
	Noon	17° 03′ N.	16° 52′ N.	92° 54′ E.	92° 58′ E.	·100	85	·909	Variable	...	
	4 P.M.	...	...	...	...	29·980	85	·789	W. S. W.	2	
	8 ,,	...	...	...	...	30·080	84	·811	S. W.	2	Smooth sea; swell from west-south-west.
	Midnight	...	...	...	...	·000	83	·814	...	2	
Shahjehan	10 A.M.	...	...	...	...	29·920	83	29·814	W. S. W.	5	10 A.M. Fresh breeze and hazy weather; heavy swell from south-west; 4 P.M. fresh breeze and hazy weather; long southerly swell: vivid lightning all round.
	Noon	18° 50′ N.	...	...	...	...	...	...	..	...	
	4 P.M.	...	19° 19′ N.	...	89° 52′ E.	·836	83	·731	S.	5	
Tibre	4 A.M.	...	...	...	...	29·686	...	29·036	S. S. W.	5	Squally; strong wind and rain; sea very rough.
	8 ,,	...	...	...	...	·784	...	·734	S. S. W.	5	
	Noon	19° 21′ N.	19° 30′ N.	87° 43′ E.	87° 49′ E.	·804	...	·750	S.	4	
	4 P.M.	...	...	...	...	·776	...	·726	S. S. W.	5	
	8 ,,	...	...	...	...	·831	...	·781	...	5	Passing squalls with rain.
	Midnight	...	...	...	...	·859	...	·809	...	4	
Marion King	4 A.M.	...	...	...	...	...	...	...	...	6	Strong breeze and variable weather, with heavy squalls and rain; overcast sky with thunder and lightning.
	8 ,,	...	...	...	...	...	...	...	...	6	
	Noon	...	19° 49′ N.	...	87° 21′ E.	...	...	...	S. W. to W.	8	
	4 P.M.	...	...	...	...	...	...	...	...	6	
	8 ,,	...	...	...	...	...	...	...	...	6	
	Midnight	...	...	...	...	...	...	...	...	5	
Castore	Noon	20° 5′ N.	20° 49′ N.	87° 48′ E.	87° 38′ E.	30·040	...	...	S. W.	2	Cloudy.
	4 P.M.	...	...	...	...	·001	...	...	...	...	
	8 ,,	...	...	...	...	·079	...	...	...	...	
	Midnight	...	...	...	...	·197	...	...	...	...	
Belfast of Liverpool	2 A.M.	...	...	...	...	29·808	83	29·073	...	...	The wind changed to south-south-east shortly after 4 A.M. & wore ship to westward. The weather cleared up, and the day was fine. Evening, rather squally looking, and cloudy with lightning; one rather heavy squall between 11 P.M. and midnight, the cloud of which was in the west-north-west; but the wind blew from about south-west.
	3¼ ,,	...	...	...	...	·800	82	·668	S.	7	
	4 ,,	...	...	...	...	·800	82	·668	S.	7-8	
	7¼ ,,	...	...	...	...	·840	82	·708	S. S. E.	7	
	8 ,,	...	...	...	...	·842	82	·710	S. S. E.	7	
	10 ,,	...	...	...	...	·878	83	·743	S. S. E.	7	
	Noon	20° 22′ N.	...	90° 20′ E.	...	...	...	...	...	...	
	1 P.M.	...	...	...	...	·834	84	·696	S. S. E.	7	
	3 ,,	...	...	...	...	·820	85	·680	S. S. E.	7	
	4 ,,	...	...	...	...	·808	84	·670	S.	7	
	8 ,,	...	...	...	...	·846	85	·706	S.	6	
	10 ,,	...	...	...	...	·850	85	·710	S.	6	
	11½ ,,	...	...	...	...	·856	84	·718	S. to S. S. W.	6-9	
	Midnight	...	...	...	...	·856	84	...	S. W.	3-2	
Atlantique	4 A.M.	...	19° 59′ N.	...	89° 39′ E.	29·686	...	29·711	S. S. W.	8	Morning—Frequent squalls; winds very violent; heavy rain; sea very high. Noon—Sky clouded; strong winds; squalls with slight rain; much lightning.
	8 ,,	...	20° 24′ N.	...	89° 4′ E.	·646	...	·671	...	8	
	Noon	...	20° 26′ N.	...	89° 4′ E.	·686	...	·711	S.	7	
	4 P.M.	...	20° 35′ N.	...	88° 39′ E.	·646	...	·671	S. W.	6	
	8 ,,	...	20° 37′ N.	...	88° 27′ E.	·705	...	·730	W. S. W.	5	
	Midnight	...	20° 32′ N.	...	88° 20′ E.	·725	...	·750	...	4	
		...		...	88° 24′ E.						
Duke of Devonshire	4 A.M.	...	...	...	...	29·560	...	29·600	S. W.	7	Morning—Fresh gale; heavy southerly sea. Noon—Squally. Afternoon—Violent rain; dense masses of clouds in the east and south; terrific lightning and thunder; ship struck, the lightning cutting the conductor in three places. Strong current to west.
	8 ,,	...	...	...	...	·660	...	·700	...	7	
	Noon	...	...	...	...	·630	...	·670	S.	6	
	4 P.M.	20° 34 N.	...	...	88° 17′ E.	·680	...	·720	...	6	
	8 ,,	...	...	...	...	·720	...	·760	...	6	
	Midnight	...	...	...	...	·730	...	·770	...	6	
F. L. V. Star	10 A.M.					29·790	83	29·646	W. S. W.	7	Sea very heavy; torrents of rain. Thunder and lightning; the latter not of a dangerous character.
	4 P.M.	Mutla		...	...	·750	81	·611	S.	6	
	...	...	...	...	...	...	...	...	...	...	
		...	...	...	...						
F. L. V. Meteor	10 A.M.					29·750	82	29·658	S. S. E.	6	Moderate sea and swell.
	4 P.M	Eastern Channel			...	·700	81	·611	S.	4	
		...	...	...	...						
F. L. V. Comet	10 A.M.					29·704	82	29·652	S. S. W.	5	Heavy cross sea and moderate gale; thunder and lightning at 7 P.M.
	4 P.M.	Intermediate Station.		...	...	·732	82	·590	S.	6	
				...	...						
Navarino	4 A.M.					...	...	...	S. S. W.	4	A.M.—Heavy squalls with rain; wind veering from south to south-west. 3 A.M.—Weather improving. 8 A.M.—Overcast.
	8 ,,	...	...	...	...	...	...	...	S. W.	5	
	Noon	...	...	...	...	29·720	...	29·670	S. W.	5	
	4 P.M.	Mud Point Saugor		...	...	...	...	...	S. S. W.	4	
	8 ,,			...	...	...	...	...	S. W.	3	
	Midnight	...	...	...	...	...	...	...	S. W.	3	
		...	...	...	...						
Ellora	4 A.M.					...	...	...	S. S. E.	8	A.M.—Strong breeze; fresh gale with violent rain, squalls and lightning. P. M.—Wind and weather moderating.
	8 ,,	Calpee Roads				...	...	...	...	6	
	Noon	...				...	...	...	S. S. W.	7	
	4 P.M.	Mud Point.				...	...	...	S.	7	
	8 ,,	Off Intermediate L. V.				...	...	...	S. S. W.	8	
	Midnight	Eastern Channel towards False Point				...	...	...	...	4	
		...									
Maharatta	8 A.M.					...	...	...	S. W.	...	Strong breeze and cloudy.
	Noon	Hooghly River				...	...	...	...	...	Ditto ditto.
	4 P.M.	.....				...	...	...	...	...	Ditto ditto.
	8 ,,	... ..				...	...	...	...	...	Threatening weather throughout; fresh breeze and high sea.
	Midnight	Eastern Channel Light				...	...	...	...	...	

The following gives briefly the character of the weather in the Bay. At the entrance and over the south of the Bay, light to moderate winds prevailed. The winds increased in strength northwards, and in lat. 16° N. were of strength 4. Further north, weather was more unsettled. In lat. 19° N., as experienced by the *Tibre*, *Shahjehan*, and *Marion King*, fresh to strong winds, of strength 4 to 6, were blowing. The weather was still squally with rain, the sky overcast, the sea very high, and thunder and lightning of frequent occurrence. To the north of lat. 20° N., the weather was similar in character, except that the winds were stronger, the squalls more violent, and the rain much heavier. The *Belfast of Liverpool*, *Atlantique*, *Duke of Devonshire*, and the light-vessels furnish concurrent evidence. The rainfall, judging from the statements in the logs, seems to have been of the usual torrential character in the eastern quadrant of the disturbance, and continued during the whole day. The weather began to improve in the afternoon and evening. The *Duke of Devonshire* was struck by lightning, which appears to have been a more prominent feature in this storm than is usual in cyclonic storms in the Bay of Bengal,—one, moreover, which was conspicuously absent during its passage over Bengal.

October 17th.—The following table gives meteorological data for the 17th of October:—

Stations.	Barometer reduced to sea-level.	Variation from mean.	Wind Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·929	−·025	SW	?	9·0	132	0·03	...
Galle	29·926	+·044	NW	?	11·0	157	...	...
Trincomalee	29·842	+·002	SW	?	16·0	160	...	...
Negapatam	29·912	−·013	W	?	4·0	94	1·25	...
Madras	29·863	−·048	W	?	5·0	98	...	*b. c.*
Coconada	29·863	?	NW	?	5·0	?	...	*b. c.*
Vizagapatam	29·865	−·034	W	E by S	2·0	95	0·10	*b. c.*
Gopalpore	29·870	?	NNW	SE	7·0	?	...	...
False Point	29·881	−·028	N	WNW	?		0·50	*g.*
Cuttack	29·860	−·055	W	NW	3·0	143	...	*b. c.*
Saugor Island	29·860	−·038	NNW	WNW	11·0	190	0·11	*b.*
Chittagong	29·916	−·005	SSE	S	8·0	248	0·25	...
Akyab	29·949	+·035	SE	SSW	3·0	130	...	*b. c.*
Diamond Island	29·965	+·045	ESE	Calm	3·0	45	0·18	*b. c.*
Port Blair	29·940	+·077	WSW	SSE	3·5	53	...	*b. m.*
Nancowry	29·923	+·033	NE	W	3·4	52	1·48	*r.*
Calcutta	29·868	−·044	WNW	W	5·0	147	0·02	*b. c.*
Patna	29·921	+·003	E	E	6·0	334	1·04	*o.*
Allahabad	29·853	−·073	W	E	1·0	77	...	*b.*
Lucknow	29·837	−·084	Calm	Calm	3·0	168	...	...
Lahore	29·797	−·111	E	Calm	1·0	56	...	*b.*
Bombay	29·930	−·009	SSE	NW	7·0	72	...	*b. c.*
Nagpore	29·888	−·049	Calm	NNW	4·0	121	...	*b. c.*

During the preceding 24 hours, a rise of pressure had occurred over the whole country. It was not large in amount except in Bengal, Behar, Chutia Nagpore, the Central Provinces, and Orissa. The rapid rise of the barometer, more especially in Bengal, not merely entirely obliterated the low pressure, which had been established for the previous three days, but caused the seat of minimum pressure in India to be transferred to Upper India for a short time. The only trace of its existence on the morning of the 17th was a very slight depression at Purneah and Berhampore, as compared with the neighbouring stations.

The winds in Bengal had fallen off very rapidly, and they had shifted round to north at the head of the Bay. In Northern and Central Bengal, they still indicated cyclonic circulation, but it was rapidly diminishing in amount in consequence of the disintegration of the vortex. In Upper and Central India, calms were observed at many stations; at the others, light westerly or north-westerly winds had now fairly set in.

The skies continued overcast in Bengal and Assam during the earlier part of the day. They were cloudless in the Punjab, North-Western Provinces, and Rajputana, and lightly clouded in the centre and south of India.

The rainfall in Bengal for the 24 hours preceding 6 P.M. of the 17th is shown in the following table, similar to those given for the 14th, 15th, and 16th:—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	...	...	Tipperah	0·65	1·75
Cuttack	...	...	Hill Tipperah	1·03	1·03
Balasore	0·01	0·05	Mymensingh	1·33	3·50
Midnapore	...	...	Pubna	0·15	0·30
24-Pergunnahs	0·02	0·08	Bogra	0·28	0·74
Howrah	0·09	0·14	Rajshahye	0·05	0·09
Hooghly	...	...	Maldah	0·19	0·19
Burdwan	0·01	0·04	Dinagepore	0·25	0·75
Bankoora	0·04	0·15	Rungpore	2·57	3·53
Beerbhoom	0·18	0·50	Julpigoree	5·95	6·93
Nuddeah	0·10	0·29	Cooch Behar	2·00	3·63
Khoolna	2·39	6·70	Darjeeling	5·71	6·27
Jessore	0·09	0·35	Purneah	1·43	2·56
Moorshedabad	0 05	0·15	Bhagulpore	0 65	1·55
Chittagong	0·07	0·14	Durbhanga	0·20	0·37
Ditto Hill Tracts	0·13	0·25	Mozufferpore	0·09	0·27
Backergunge	0·97	2·60	Chumparun	...	...
Noakhally	0·63	0·88	Sarun	...	...
Furreedpore	0·64	1·13	Shahabad	0·04	0·16
Dacca	0·87	1·90	Gya	0·02	0·07

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Patna	0·25	0·49	Lohardugga	...	...
Monghyr	0·24	0·64	Manbhoom	...	...
Sonthal Pergunnahs . .	0·82	3·60	Singbhoom	...	...
Hazaribagh	0·03	0·15			

The general character of the weather in North Bengal during the storm is given in the following account of it as experienced at Dhubri during the 16th and 17th:—

"The sky became overcast with thick clouds, from 7 A.M. on the morning of the 15th. Drizzling rain fell at intervals till 3-30 P.M., when it ceased for an hour. At 4-30 P.M. the wind increased considerably in force and rain again began to fall. The wind continued to increase in intensity throughout the whole night and on the morning of the 16th, and blew with an average velocity of 28 miles per hour from midnight to 9 A.M. The wind then began to come in furious gusts from the east-north-east, and shifted from one direction to another at short intervals of two or three minutes. The mercury column of the barometer oscillated rapidly up and down during the day. At 9 P.M. on the 16th, a sudden peal of thunder was heard directly overhead. The storm lasted for 36½ hours, from 9-30 A.M. of the 16th to 9 P.M. of the 17th. Rain fell throughout the whole of the storm. The sky was overcast, and weather gloomy from 7 A.M. of the 15th to 8 P.M. of the 18th, when the air became calm, and the sky clear."

Vessels.	October 17th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
The Bruce . .	Noon	4° 35′ S.	4° 38′ S.	85° 17′ E.	85° 04′ E.	...	...	...	W. S. W.	2	Light airs first and middle part of the day, latter part squally with rain.
Tibre	4 A.M.	...	...	...	...	29·843	...	29·793	S. S. W.	4	Sky cloudy.
	8 ,,	...	...	...	...	·922	...	·872	...	4—5	Sea rough.
	Noon	16° 58′ N.	17° 18′ N.	84° 56′ E.	85° 14′ E.	·941	...	·891	...	4—3	
	4 P.M.	...	...	...	...	·863	...	·813	S. W.	4	Long swell, fine weather.
	8 ,,	...	...	...	...	·922	...	·872	...	4—3	
	Midnight	...	...	...	...	·875	...	·825	...	4—3	
Erin's Gem . . .	4 A.M.	...	...	...	...	...	...	...	S. S. E.	2—3	A.M.—Light airs from south-south-east. Lightning from midnight to 5 A.M. At noon swell from south-west. Passing clouds mostly from south-west. At 9-30 P.M. south-west swell. Midnight. Faint airs and clear.
	9-30 ,,	...	...	...	...	29·860	...	29·910	S.	...	
	Noon	17° 21′ N.	17° 26′ N.	90° 20′ E.	90° 15′ E.	·830	...	·880	S. by W.	...	
	4 P.M.	...	...	...	...	·780	...	·830	to	...	
	9-30 ,,	...	...	...	...	·860	...	·910	S. W.	...	
	Midnight	...	...	...	...	...	...	...	...	2	
Hutton	Noon	18° 51′ N.	...	89° 49′ E.	...	29·800	...	29·850	S. S. W.	4	Moderate sea rolling from south-south-west; cloudy.
Ellora	4 A.M.	Eastern Channel towards False Point.				...	...	...	S. W.	3	A.M.—Light breeze and cloudy, with vivid lightning in the south-west.
	8 ,,					...	...	...	...	...	
	Noon					...	...	...	...	...	
	4 P.M.					...	...	...	...	...	P.M.—Calm and fine.
Burroora . . .	4 A.M.	...	...	...	...	29·990	83	29·804	...	...	Light breeze and cloudy. Lightning to north. Current N. 17° W. 15 miles; swell from south-west.
	8 ,,	...	...	...	...	30·000	82	·817	...	...	
	Noon	20° 01′ N.	19° 46′ N.	89° 40′ E.	89° 42′ E.	·000	85	·809	...	...	
	4 P.M.	...	...	...	...	29·970	84	·781	W. by S.	...	
	8 ,,	...	...	...	...	30·020	83	·834	Variable	...	
	Midnight	...	...	...	...	·000	82	·817	...	...	

Vessels.	Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D R	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Atlantique	4 A.M.	...	20° 24′ N.	...	88° 20′ E.	29·688	...	29·711	S. W.	4	Morning—Weather fine; winds decreasing rapidly in strength. Sea smooth. Afternoon—Foggy; calm.
	8 ,,	...	20° 29′ N.	..	88° 27′ E.	·825	...	·850	...	3	
	Noon	...	20° 35′ N.	...	88° 24′ E.	·825	..	·850	W.	2	
	4 P.M.	..	20° 33′ N.	...	88° 20′ E	·764	...	·789	S. S. E.	1	
	8 ,,	...	...	...	...	·804	...	·829	Calm	...	
	Midnight	...	...	...	...	·843	...	·868	...	...	
Nith	4 A.M.	...	...	...	...	...	...	...	S. by W.	...	Weather clearing Noon.—Weather fine and clear. Evening, occasional rain showers.
	8 ,,	...	...	...	...	...	...	...	S. W.	...	
	Noon	20° 49′ N.	...	89° 35′ E.	...	29·800	..	...	S. W.	2	
	4 P.M.	...	...	...	...	...	...	...	S.W. by S.	2	
	Midnight	...	...	...	...	...	...	...	Calm	...	
Belfast of Liverpool	4 A.M.	...	...	...	...	29·840	83	29·705	S.	3	Wind died away after daylight until it was nearly calm at 2 P.M. Sudden rise in the mercury between 4 and 8 A.M.
	4½ ,,	...	...	...	...	·840	83	·705	S.	3	
	8 ,,	...	...	...	...	·962	82	·829	Variable	1—2	
	10 ,,	...	...	...	...	·972	82	·839	Calm	...	
	Noon	Eastern Channel Light Ship North 8 miles.				...	...	..	...	...	
	4 P.M.					·914	82	·787	S.	2	
	8 ,,	...	...	...	...	...	...	...	...	...	
Shahjehan	10 A.M.	...	...	...	...	29·960	82	29·857	Variable	...	Light breeze and fine clear weather.
	Noon	Eastern Channel Light Vessel.		...	...	...	...	...	...	...	
	4 P.M.	Anchored at Saugor.		...	...	·910	81	·809	N.W. by N.	3	
Duke of Devonshire	4 A.M.	...	...	...	...	29·730	...	29·770	S.	5	Moderate wind; unsettled appearance to south-east and south; sky clearing to the north.
	8 ,,	Saugor.		...	...	·800	...	·840	...	3	
F. L. V. Star	10 A.M.	Mutla.		...	...	29·960	81	29·819	S. S. E.	2	Sea slight.
	4 P.M.	...	...	...	...	·900	81	·759	S. S. W.	3	
F. L. V. Meteor	10 A.M.	Eastern Channel.				29·880	81	...	W.	1	Moderate sea and swell.
	4 P.M.	...	...	...	...	·850?	81	...	Calm	...	Ditto ditto.
Marion King	4 A.M.	...	...	...	...	...	...	...	...	2	Light breeze with clear weather and smooth sea.
	8 ,,	...	...	...	...	...	...	...	...	3	
	Noon	...	21° 2′ N.	...	87° 18′ E.	...	...	...	S. W.	2	
	4 P.M.	...	...	...	...	...	...	...	...	3	
	8 ,,	...	...	..	...	...	...	...	...	3	
Navarino	4 A.M.	...	...	...	...	...	...	...	N. W.	4-7	8 A.M.—Dull cloudy weather throughout. 8 P.M.—Fine and clear; moderate south-west swell.
	8 ,,	...	...	...	...	...	...	...	N. E.	2	
	Noon	Sandheads.			...	...	...	...	N. E.	2	
	4 P.M.	...	...	...	...	...	...	...	S.	2	
	8 ,,	...	...	...	...	...	...	...	S.	2	
	Midnight	...	...	...	...	...	...	...	S.	2	
Maharatta	4 A.M.	Near Mutla Lt. Ship.				...	...	...	S. W.	...	Fresh breeze and cloudy weather. Fresh breeze; fine weather.
	8 ,,	...	...	...	...	...	...	...	...	...	
	Noon	21° 0′ N.	...	90° 35′ E.	...	...	...	...	...	...	
	4 P.M.	...	...	...	...	...	...	...	S. S. E.	...	
	8 ,,	...	...	...	...	...	...	...	...	...	
	Midnight	...	...	...	...	...	...	...	...	...	
F. L. V. Comet	10 A.M.	Intermediate Station.				29·980	81·5	29·838	N.	1	A swell from south-south-east. Wind light and variable from north.
	4 P.M.	...	...	...	...	·884	80	·747	N.	1	
Purulia	4 A.M.	...	...	...	...	29·800	83	29·750	S. S. E.	4	1-30 A.M.—Strong rain and wind squalls from north-west. 4 A.M.—Moderate breeze and fine weather. 8 A.M.—Light breeze and fine weather.
	8 ,,	Anchored at Diamond Harbour.				·900	81	·850	W.	2	

The number of vessels traversing the Bay from which logs have been received for the 17th are smaller in number than hitherto, but are still sufficient to indicate fully the character of the weather. The only vessel in the south of the Bay was the *Madura* in lat. 10° 4′ N. and long. 97° 16′ E. She had light north-easterly winds, and a smooth sea. In the centre of the Bay, the *Tibre* and *Erin's Gem* had light to moderate winds with a cloudy sky, which gradually cleared up during the day. The *Bancoora*, *Atlantique*, *Nith*, *Belfast of Liverpool*, *Maharatta*, and *Navarino* were all near the Sandheads. The winds early in the morning were of moderate strength, varying from 3 to 4. They gradually died away, and calms were recorded by three of the vessels in the afternoon. The light-vessels *Star* and *Meteor* confirm this evidence. Before the evening of this day the southerly winds at the head of the Bay had become unsteady, and blew only as gentle airs. The sky had also cleared, and weather was fine, and the sea slight with a long south-west swell.

October 18th.—The following table gives the meteorological data for the 18th October:—

Stations.	Barometer 10 A. M. reduced to sea-level.	Variation from mean.	Directions.		Wind velocity.	Percentage of actual to average air motion.	Rainfall.	Weather.
			10 A.M.	4 P.M.				
Colombo	29·919	−·035	SSW	?	4	59	...	...
Galle	·914	+·032	W	?	6	86	...	...
Trincomallee	·880	+·040	SW	?	10	100	...	...
Negapatam	·895	−·030	W	?	2	47	...	Sultry.
Madras	·903	−·008	W	?	3	59	...	...
Coconada	·920	?	NE	?	7	?	...	...
Vizagapatam	·921	+·022	NE	E	1	48	...	...
Gopalpore	·925	?	N	NE	6	?	...	...
False Point	·945	+·036	NNE	E	1	17	...	*b.*
Cuttack	·923	+·008	NW	NE	1	48	...	*b. c.*
Saugor Island	·922	+·024	NW	WNW	3	52	...	*b.*
Chittagong	·944	+·023	SSW	WSW	6	188	...	*b. c.*
Akyab	·958	+·044	E	W	1	43	...	*b. c.*
Diamond Island	·951	+·031	NE	NW	3	45	...	*b .c.*
Port Blair	·940	+·077	N	N	5	76	0·42	*c.*
Nancowry	·920	+·030	NE	WSW	1	15	...	*c.*
Calcutta	·931	+·019	W	WNW	2	59	...	*b. c.*
Burdwan	·930	+·007	NNW	Calm	2	91	0·04	*o.*
Patna	·969	+·051	E	Calm	3	167	0·34	*o.*
Allahabad	·922	−·004	NW	NE	1	77	...	*b.*
Lucknow	·914	−·007	WNW	Calm	1	56	...	*b.*
Lahore	·862	−·046	Calm	Calm	1	56	...	*b.*
Bombay	·949	+·010	ENE	NNW	9	93	...	*b.*
Nagpur	·939	+·002	Calm	NNE	3	91	...	*b. c.*

The returns of the afternoon of the 17th show that the depression in Bengal had completely disappeared, and the cyclonic circulation was so thoroughly broken up, that light local winds only were then prevalent. The observations for the morning of the 18th confirm these facts. A further rise of the barometer took place over the whole of India, largest in Upper India. The effect of these changes was the establishment of uniform pressure over the Bay of Bengal, Bengal, the North-Western Provinces, the Central Provinces, the Deccan, and the Madras Presidency. In Upper India, light and variable winds continued; but over Assam, Bengal, Burma, and the Bay, north-easterly winds set in, and were blowing with some force in Assam. The skies were overcast in Assam and North Bengal, but elsewhere in Northern India, they were clear, and weather was fine.

The following table gives the rainfall in the various districts in Bengal for the 24 hours preceding 6 P.M. of this day:—

Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.	Districts.	Average Rainfall of the District.	Heaviest Rainfall in the District.
	Inches.	Inches.		Inches.	Inches.
Pooree	...	...	Bogra	0·06	0·12
Cuttack	0·02	0·10	Rajshahye	0·03	0·06
Balasore	...	..	Maldah	0·06	0·06
Midnapore	...		Dinagepore	...	...
24-Pergunnahs	...	..	Rungpore	0·04	0·10
Howrah	...	...	Julpigoree	0·20	0·40
Hooghly	0·04	0·12	Cooch Behar	0·06	0·11
Burdwan	...	..	Darjeeling	0·36	0·44
Bankoora	...	...	Purneah	0·01	0·03
Beerbhoom	0·02	0·06	Bhagulpore	0·01	0·03
Nudden	...	...	Durbhanga	...	...
Khoolna	0·61	1·84	Mozufferpore	0·40	1·20
Jessore	...	...	Chumparun	...	...
Moorshedabad	0·02	0·06	Sarun	...	...
Chittagong	0·19	0·37	Shahabad	...	...
Ditto Hill Tracts	...	...	Gya	...	...
Backergunge	0·06	0·20	Patna	...	...
Noakhally	0·33	0·65	Monghyr	...	...
Furreedpore	...	...	Sonthal Pergunnahs	...	...
Dacca	0·11	0·30	Hazaribagh	...	...
Tipperah	0·53	0·75	Lohardugga	...	...
Hill Tipperah	0·74	0·74	Manbhoom	...	...
Mymensingh	0·02	0·10	Singbhoom	...	...
Pubna	0·05	0·10			

Vessels.	October 18th. Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Tibre	4 A.M.	...	...	...	...	29·992	...	29·832	S. W.	2	Fine clear weather.
	8 ,,	...	...	...	...	·961	...	·911	Calm	...	South-west swell.
	Noon	14° 21′ N.	14° 30′ N.	81° 27′ E.	81° 47′ E.	·981	...	·931	Calm	...	
	4 P.M.	...	...	...	..	·902	...	·852	Calm	...	
	8 ,,	...	...	...	...	·922	...	·872	S. W.	3	Sea smooth.
	Midnight	...	...	...	...	·961	...	·911	...	3-4	
Navarino	4 A.M.	...	...	...	...	...	...	...	S. W.	2	Current S. 46° W. 53 miles in 24 hours; fine weather.
	8 ,,	...	...	...	...	...	...	...	...	1	
	Noon	16° 1′	18° 35′ N.	85° 4′ E.	85° 39′ E.	29·840	82	...	N. E.	2	
	4 P.M.	...	...	...	...	...	...	...	S. E.	2	

Vessels.	October, 17th Hour.	Latitude. Obsd.	Latitude. D. R.	Longitude. Obsd.	Longitude. D. R.	Barometer. Height.	Barometer. Attd. Therm.	Probable reduced Barometer.	Winds. Dir.	Winds. Force.	Remarks.
Erin's Gem	3·30 A.M.	...	...	...	...	29·880	...	29·850	S W.	2	Light airs and calms. Very clear and fine. Lightning to north.
	4 ,,	...	...	...	...	·880	...	·850	...	2	
	8 ,,	...	...	...	...	·860	...	·910	...	1	
	9-30 ,,	...	...	...	...	·860	...	·910	...	...	
	Noon	18 33′ N.	18 33′ N.	9 00′ E.	89 54′ E	·840	...	·880	Calm	...	
	4 P.M.	...	...	...	...	·780	...	·830	W. S. W.	1	
	8 ,,	...	...	...	...	·840	...	·890	...	1	
Marion King	Noon	...	20° 42′ N.	...	87° 3′ E.	...	...	...	Calm	...	Calm and clear sky; smooth sea; current setting to south-west.
Altantique	4 A.M.	...	20° 33′ N.	...	88° 20′ E.	29·882?	...	29·907?	Calm	...	Calm.
	8 ,,	...	...	...	...	·882	...	·907	...	...	
	Noon	20° 53′ N.	20° 38′ N.	87 56′ E.	88° 27′ E.	·882	...	·907	N. N. E.	3	
	4 P.M.	...	20° 48′ N.	...	88° 0′ E.	·843	...	·868	E. N. E.	2	
	8 ,,	...	...	...	...	·882	...	·907	Calm	...	
	Midnight	...	...	...	...	·863	...	·888	...	...	
Bancoora	4 A.M.	...	...	...	...	29·990	83	29·904	N.	3	Gentle breeze, and fine,
	8 ,,	...	...	...	...	...	...	...	...	...	
	9-30 A.M.	Saugor	...	...	...	30·040	82	·857	...	...	
	10 ,,	...	...	...	...	·040	82	·857	...	...	
	4 P.M.	...	...	...	...	·060	82·5	·875	...	...	
	7 ,,	...	...	...	...	·060	83	·874	...	...	
F. L. V. Star	10 A.M.	Mutla	..	...	...	30·036	80·3	29·897	N. N E.	1	Sea light.
	4 P.M.	...	...	...	...	29·954	83	·808	Calm	...	Ditto.
F. L. V. Meteor	10 A.M.	Eastern Channel		...	...	29·960	85	29·869?	N.	3	Sea smooth; slight swell.
	4 P.M.	...	...	...	...	·916	88	·817	Calm	0	
F. L. V. Comet	10 A.M.	Intermediate Station.		...	...	30·062	82	29·919	N.	1	Fine weather; slight swel.
	4 P.M.			...	...	29·950	85	·799	Variable	1	

The weather of the 18th in the Bay was exactly similar to that which had prevailed on the previous evening. The *Tibre*, in lat. 14° 21′ N. and long. 81° 27′ E., had calms, fine clear weather, and smooth sea. The *Navarino*, in lat. 18° N. and long. 85° 4′ E., had light variable winds and fine weather. The *Ellora*, off the Orissa Coast, experienced light airs and calms. The light-vessels had light northerly winds in the morning, and calms in the afternoon. The stormy weather had thus completely passed away from the Bay, and was replaced by the ordinary October weather of light variable airs, clear skies, and a smooth sea.

CHAPTER III.

Discussion of the more important features of the storm.

The following is a brief statement of the more important facts relating to the cyclone of the 10th to 18th October. The south-west monsoon rains terminated in the North-Western Provinces during the last week of September. Rain continued to fall at intervals, in moderate amounts, until the 4th of October in Behar, the 5th in North and Central Bengal, and the 6th in South and East Bengal. On the morning of of the 7th, fine weather with clear skies, and light winds drawing round to the north, prevailed over the whole of Bengal. The extracts from the logs of vessels show that the retreat of the south-west monsoon current was followed by its recurvature over the centre and north of the Bay. This recurvature necessarily gave an apparent feeble cyclonic circulation over the centre of the Bay. Under certain conditions which have not yet been fully investigated, the south-west current after recurvature reaches the Madras coast, giving strong north-east winds, heavy rain, and a high sea. This forms what is termed the setting in of the north-east monsoon on the Coromandel coast. Under other conditions, the rain, instead of falling over the coast, is precipitated at sea,

and tends to establish a cyclonic whirl. If the rain be sufficiently concentrated and localized, the whirl thus produced may develop into a severe and dangerous cyclone. The logs of several ships prove that, on this occasion, rain began to fall over the south of the Bay on the 7th. They also indicate that the rainfall for some time was diffused over a considerable area. Squalls occurred at frequent intervals during the 8th, 9th, 10th and 11th, but the winds, although indicating atmospheric disturbance and irregular cyclonic action, were by no means strong, and were somewhat variable in direction. There was also a tendency to slight barometric depression, but so small as to be in itself of little importance, as it almost certainly did not exceed ·05″ at any time during this period. On the morning of the 12th, a clearly defined, but small, barometric depression was formed in the south-west of the Bay, the centre of which was in about lat. 13° N. and long. 85½° E. Over this area of disturbance, squalls increased in frequency and force during the day, and rainfall occurred with greater intensity, whilst the sea rose fast, and the weather and sky assumed a threatening and gloomy appearance. The depression increased in amount, and moved northwards. The centre at noon of the 13th was approximately in lat. 16° N. and long. 85½° E. The height of the barometer at the centre was probably not lower than 29·65 inches or ·25 inch below the normal pressure of the period. The centre advanced to lat. 19° N. and long. 85½° E. during the next 24 hours, and was thus, at noon of the 14th, near the coast of the Circars and Orissa. It crossed the Orissa coast near to, and probably a little south of, Pooree during the afternoon, and continued to advance northwards, and almost parallel to the Orissa hills, during the remainder of the day.

The depression intensified considerably at this time, and at noon of the 14th the height of the barometer at the centre probably did not exceed 29·5 inches, so that the depression exceeded ·4 inch. The centre passed a little to the west of Cuttack late on the evening of the 14th. The depression at that time was an elliptical shaped area, its longest axis lying north-west and south-east. The centre of the depression at 10 A.M. of the 15th was approximately in lat. 21° 20′ N. and long. 86° 45′ E., and was in the Balasore district of Orissa. It then marched apparently near and to the west of the edge of the broken ground of Chutia Nagpore and the Sonthal Pergunnahs. It was apparently in lat. 22° 45′ N. and long. 87° 45′ E. at 10 A.M. of the 16th, and in lat. 23° 30′ N. and long. 87° 45′ E. at 4 P.M. The depression was, as hitherto, elliptical-shaped, but its longest axis ran from south-west to north-east. The height of the barometer at the centre of the depression was probably not below 29·6 inches, so that it was commencing to fill up, and also to extend over a larger area than hitherto. Very heavy rain had fallen, and continued to be received over the eastern quadrant of the disturbance, or over the whole of Bengal. The depression filled up very rapidly during the next 24 hours. The centre was nearly midway between Berhampore and Purneah in lat. 24° 45′ N. and long. 87° 45′ E. at 10 A.M. of the 17th, but the barometer at the centre had now risen to 29·83 inches. Heavy rain continued to fall for a few hours longer in Northern Bengal, and the more western districts of Assam. It filled up on the evening of the 17th, so completely, that the winds at the majority of stations in Bengal at 10 A.M. of the 18th contained a northerly element, and were reverting to their cold-weather directions. Skies were clear, and light north-westerly winds were established over the whole Province before the evening. The storm hence lasted from the morning of the 12th until the morning of the 18th.

The following table gives the data for determining the motion of the storm centre :—

Time.	Position.		Distance travelled during previous 24 hours.	Rate of motion in miles per hour during the preceding 24 hours.
	Latitude.	Longitude.		
12th noon	13° N.	85° 30′ E.	...	...
13th noon	16° N.	85° 30′ E.	210	9
14th noon	19° N.	85° 30′ E.	210	9
15th 10 A.M.	21° 20′ N.	86° 45′ E.	180	7½
„ 4 P.M.	21° 40′ N.	87° 0′ E.	...	...
16th 10 A.M.	22° 45′ N.	87° 45′ E.	105	4½
„ 4 P.M.	23° 30′ N.	87° 45′ E.	...	...
17th 10 A.M.	24° 45′ N.	87° 45′ E.	140	6
„ 4 P.M.	25° 15′ N.	88° E.	...	...

This shows that it advanced due north from its origin on the 12th until the 15th, when it curved slightly, and advanced north-north-east. It approached the Orissa hills on the 14th, and advanced parallel with them at a distance of a few miles. The whirl then apparently rolled along the edge of the high and irregular ground of the Chutia Nagpore plateau, and the Sonthal Pergunnahs. It crossed the Ganges near Rajmahal into North Behar and Bengal, and was shortly afterwards broken up by the disintegrating effect of the lower Himalayas on the cyclonic motion.

The fact that the motion of the centre was deflected by the comparatively low ground of the Chutia Nagpore plateau, seems to be a sufficient proof that the main body of the cyclonic disturbance was confined to the lowest strata of the atmosphere, or that the cyclone resembled those which usually occur during the October transition period, in being one of low elevation. This is further confirmed by the statement of several observers in South Bengal, that the scud or low drifting cloud, which forms a conspicuous feature in all cyclonic disturbances in Bengal, was unusually low during the greater part of the storm in Bengal. It is also confirmed by the fact that, although the depression was unusually small, and the gradients, more especially on the 17th, were very slight (probably not exceeding ·1 inch per 300 miles), very strong winds blew in North Bengal. A reference to the wind velocities calculated from the traces of the Casella's anemograph at Dhubri given in pages 205-6 will show the truth of this statement.

The first important feature of the storm was the unusual slowness with which it was formed and its general diffuse character at sea.

It has been already stated that rain ceased to fall in Bengal on the 6th, and that the steady southerly winds, which had previously been prevalent, were replaced by light unsteady northerly winds. The south-west monsoon current, although it had been displaced from Bengal and was weak at the time, can be distinctly traced in the Bay. The follow-

ing observations of the 8th (similar to those of the 7th) prove that it curved through south-east, east, and north-east over the centre of the Bay :—

Vessels.	Position.		Wind.	Weather.
	Latitude.	Longitude.	Direction.	
Nancowry	.....	.....	W S W	Fine.
Port Blair	.....	.....	S S E	Fine.
Diamond Island	.....	.....	S E	Fine.
Akyab	.....	.....	E	Fine and clear.
S. S. Madura	19° 18′ N	90° 10′ E	E	Fine and clear.
S. S. Memnon	19° 54′ N	88° 5′ E	E S E	Fine and clear.
S. S. Bancoora	15° 4′ N	81° 48′ E	N E	Fine.

The preceding and similar wind observations establish the fact that the south-west winds over the south of the Bay, which were yet in moderate force, were continued on the 7th and 8th (and not before) over the centre of the Bay towards the Madras coast, thus giving rise to apparent cyclonic circulation.

The uniformity of pressure at the coast stations of the Bay on the 8th, the irregularity of the air movement at the great majority of the stations, (due evidently to local action), are sufficient to indicate the absence of cyclonic movement in the incipient stage, at that date, as introductory to a severe cyclone. The *City of Canterbury* passed from north to south on the 7th and 8th through the area in which the cyclone was formed on the 11th and 12th. The following are the main facts extracted from her log for these two days :—

Hour.	Position of Vessels.		Wind.		Remarks.
	Latitude.	Longitude.	Direction.	Force.	
7th Noon	17° 13′ N.	86° 25′ E.	S by E	3	Showers to the west ; light clouds overhead.
Midnight	15° 19′ N.	85° 34′ E.	SE by S	3	
8th Noon	13° 25′ N.	84° 46′ E.	SSW	3	Gloomy weather. Heavy rain in south-west squalls.

There were, however, indications on the 8th that, over a small portion of the area covered by the irregular cyclonic circulation, due to the recurved south-west monsoon winds, there was a tendency to the formation of an atmospheric whirl. This was not far from the Coromandel coast, apparently at or near the front of the recurved current. The conditions were, however, evidently not favourable to its speedy development. The winds remained more or less variable for some days, the rainfall apparently extending over a considerable area, and moderate in amount.

The following extracts from the logs of the vessels in and near the area of disturbance illustrate its features on the 8th :—

Vessels.	Position of Vessels.		Wind.		Weather.
	Latitude.	Longitude.	Direction.	Force.	
City of Canterbury	13° 25′ N.	84° 46′ E.	Variable.	3 to 5	Cloudy weather. Heavy rain.
Bancoora	15° 04′ N.	81° 48′ E.	N. E.	2	Light breeze. Smooth sea.
Atlantique	12° 06′ N.	80° 24′ E.	Variable.	0 to 3	Cloudy, variable weather.

There were indications of the probable commencement of stormy weather, as, for example, the occurrence of rain squalls, and the dark gloomy appearance of the sky as experienced by the *City of Canterbury*.

The observations of the 9th present similar features. Rainfall in moderate amounts continued over a largish area, and rain squalls became more frequent at sea. The chart of the day shows that at 10 A.M., a belt of very shallow barometric depression extended from the Coromandel coast to the Andamans. The winds were generally unchanged in direction over that area. The following table gives the chief facts of the weather in that area:—

Vessels.	Position.		Wind.		Weather.
	Latitude.	Longitude.	Direction.	Force.	
Nancowry	...	...	...	Moderate	Fine with passing clouds.
Port Blair	...	...	SSE	Light	Light showers.
S. S. Madura	16° 43′ N.	93° 23′ E.	E to S	1—2	Light airs; showers; slight south swell.
City of Agra	17° 28′ N.	86° 40′ E.	SE to E	2—3	Sea smooth; showers.
Shahjehan	Coconada Roads		ENE	1—3	Light airs; sea smooth; showers.
Atlantique	11° 59′ N.	81° 05′ E.	WSW to N	2—3	Cloudy; sea smooth; continuous rain during the afternoon.
City of Canterbury	9° 48′ N.	83° 21′ E.	SW to W	3—5	Moderate sea; heavy rain.

The above observations establish that rain showers were occurring over the whole of the centre and south of the Bay, but that they were nowhere heavy, except perhaps in the south, as indicated by the logs of the *City of Canterbury* and *Atlantique*.

The meteorological extracts from the logs of the vessels show a very slight further development of the initial conditions, antecedent to the formation of the atmospheric whirl during the next 24 hours. A reference to the chart for the day indicates that at 10 A.M. of the 10th there was, as on the 9th, a slight depression across the centre of the Bay.

Ships.	Position.		Wind		Weather.
	Latitude.	Longitude.	Direction.	Force.	
Kerbela	8° 15′ N.	82° 51′ E.	Var.	0-6	Calm and light winds; fresh wind and gloomy at night.
Atlantique	12° 21′ N.	82° 15′ E.	N N W to N E	3—4	Sea smooth; steady breeze; no rain.
City of Agra	13° 41′ N.	84° 54′ E.	Var.	1—5	Cloudy with showers; squally during the evening.
Shahjehan	16° 44′ N.	86° 14′ E.	E	4—5	Sea smooth; easterly squalls; cloudy.
Bancoora	16° 39′ N.	84° 34′ E.	E to E N E	3—4	Light squalls; rain.

These observations prove that on the morning of the 10th the vessels which were nearest to the centre of disturbance on the two next days, *viz.*, the *Atlantique* and *City of Agra*, had somewhat variable and light breezes. The *Atlantique* was proceeding eastward, but she notes the cessation of the rainfall. The whole of the ships,

in the part of the Bay where the cyclone subsequently originated, experienced on the morning of the 10th, light to moderate breezes, which were in several cases very variable in direction, and a smooth sea. Squalls and rain passed over the *Bancoora* and *Shahjehan* in the northern portion of the area of slight barometric depression, and over the *Kerbela* and *City of Agra* to the south of it.

Hence it is almost certain that the only change during the previous 24 hours was the contraction of the rainfall area, more especially on the western part or near the Coromandel coast. There was, therefore, as on the 9th, an area of very slight disturbance between long. 82° E. and the Andamans, and between 9° and 17° N. latitude.

The conditions were almost identical on the morning of the 11th. There was slight disturbance over the Bay to the south of lat. 17° N., and between the Coromandel coast and the Andamans. Rain was falling probably over the eastern part of this area, and certainly in Burmah, and at Nancowry and Port Blair, but there was no concentrated rainfall. Occasional squalls occurred, but the barometer remained stationary, and the winds were more or less variable. The following are the chief facts respecting the weather in this area, taken chiefly from the logs of the ships:—

Ships.	Position.		Winds.		Remarks.
	Latitude.	Longitude.	Direction.	Force.	
Nancowry	...	...	W S W	Light	Squally; heavy rain.
Port Blair	...	...	W S W	Moderate	Squally, rain.
Bancoora	15° 53′ N.	88° 21′ E.	E	2–3	Smooth sea, squally, heavy rain.
City of Agra	9° 53′ N.	83° 22′ E.	S S W & S W	2—4	Squally; gloomy; rain.
Atlantique	13° 1′ N.	83° 9′ E.	N E & E N E	1—3	Sea smooth; fresh squalls, with much rain.
Kerbela	12° 3′ N.	84° 30′ E.	Var.	2—6	Thick rain; wind increasing; squally.
Clan Macdonald	15° 1′ N.	82° 4′ E.	Variable and unsteady	3—4	Rain; sea smooth in the morning. Frequent squalls during the afternoon with heavy rain; sea smooth.
Duke of Devonshire	At	Madras.	N E	2	Frequent showers.

Here, again, as on the previous three days, there was no rapid change or development, such as usually marks the formation of a cyclone. The weather was evidently worse, squalls were more frequent and heavier, and the rainfall was increasing in amount. Two or three of the ships for the first time record heavy rain, but, as before, the rainfall was apparently spread over the whole area.

The *City of Agra* and the *Kerbela* cruised in opposite directions on this day through that part of the Bay which became the storm area of the 12th and 13th. The winds according to the statements in their logs were as unsteady and moderate, as they had been for the past two or three days, and the sea up to the afternoon of the day, smooth as before.

The meteorological information for the 12th (*vide* chart of day) shows the establishment of an area of barometric depression which rapidly developed into a cyclonic storm

The chart of the day indicates that a circular area between 10° and 17° N. latitude, and 81° and 89° E. longitude, was enclosed by the isobar of 29·8.

Vessels.	Position.		Wind.		Weather.
	Latitude.	Longitude.	Direction.	Force.	
Nancowry	.....	.....	W S W	Strong	Showery.
Port Blair	.....	.....	S W	Light	Showery.
Marion King	7 25′ N.	84° 25′ E.	S W	5—6	Squalls; rain; sea smooth.
Castore	9° 23′ N.	82° 59′ E.	W	5	Sea rough.
Atlantique	14° 8′ N.	83° 48′ E.	S E to W.	2—4	Sea smooth; rainy; winds very irregular.
Bancoora	15° 38′ N.	92° 12′ E.	E	3—6	Squalls with *heavy rain*; sea smooth.
Kerbela	15° 44′ N.	86° 8′ E.	N E	5—8	Rain squalls; heavy sea; *continuous heavy rain.*
Duke of Devonshire	15° 35′ N.	82° 44′ E	N E	4—6	Strong squalls; *heavy showers*; rough sea.
Clan Macdonald	17° 2′ N.	84° 37′ E.	N E	7	Rising sea; heavy squalls.

The *Atlantique* had the lowest barometer and was nearer the centre of the cyclonic circulation than the other vessels. The strongest winds and the heaviest squalls were apparently experienced in the northern quadrant, but the evidence is too scanty to establish this with certainty. It is, however, quite clear that heavier rain was now falling over the storm area, the squalls were much more severe, and the sea rapidly rising.

The previous discussion has shown the slow formation of the cyclonic motion. It is unnecessary following the progress of the vortex, as that has been fully done in the preceding pages.

The preceding analysis has shown that, for at least four days, *i.e.*, from the 8th to the 11th, many of the conditions known to be favourable to the formation of a cyclone in the Bay of Bengal were present. As already remarked, the conditions in October are usually those most favourable to the development of cyclonic disturbance on the large scale. Yet on this occasion there was evidently some one condition wanting during this antecedent period, and which was not present to any marked degree during the next two days, when the cyclone was certainly comparatively feeble at sea, and did not give rise to winds of hurricane force. Moreover the strongest winds in the Bay were experienced after the centre had crossed into Orissa. The only explanation suggested by the observations, and in harmony with the principles of cyclonic air motion, (and more especially of the condensation theory), is that during the antecedent period before the cyclone was established, rainfall was irregularly and widely distributed, and was not excessive in amount. Rainfall undoubtedly occurred over the whole of the centre of the Bay, from the Madras coast to Burmah and the Andamans. It was also, so far as can be estimated from the information, neither localized and concentrated in character, nor large in amount. During the 12th and 13th, the same characteristics marked the rainfall to a less degree, and although heavy rain occurred mainly at and near the centre of the depression, it never had that torrential character over a limited area, which seems to be the essential condition for the rapid development of a cyclonic disturbance. The rainfall presented the same characteristics when the storm was passing through Orissa and

Bengal. It was large in amount, but was very irregularly distributed over a very considerable area, and not localized, and was also heaviest at some distance to the east of the path of the centre in Bengal.

The following table gives the average daily rainfall of all the districts in Bengal during the period of the storm, and indicates the general distribution of the rainfall which accompanied it in Orissa and Bengal:—

Districts through which the storm centre passed.	13th.	14th.	15th.	16th.	17th.	18th.	Total.
Pooree	1·18	1·13	1·76	0 01	...	...	4·08
Cuttack	1·64	1·93	1·85	0·14	...	0·02	5·58
Balasore	1·89	2·69	1·67	0·03	0·01	...	6·29
Midnapore	0·44	1·34	4·52	1·16	...	...	7·46
Burdwan	0·23	0 19	2·55	2·65	0 01	...	5·63
Bankoora	0·44	0·31	2·73	1·05	0·04	...	4·57
Beerbhoom	0·08	0·35	2·89	2 07	0·18	0·02	5·59
Moorshedabad	0·18	0·24	2·87	2·76	0·05	0·02	6·12
Maldah	...	0·04	0 44	3·63	0·19	0·06	4·36
Dinagepore	...	0·01	2·38	3·04	0·25	...	5·68

Districts to the east of the storm centre.	13th.	14th.	15th.	16th.	17th.	18th.	Total.
Tipperah	0·23	0·59	0·86	1·38	0·65	0·53	4·24
Hill Tipperah	...	0·86	0·30	0·70	1·03	0·74	3·63
Mymensingh	...	0·02	1·79	4·27	1·33	0·02	7·43
Pubna	...	...	0·73	6·53	0·15	0·05	7·46
Bogra	...	0·07	0·49	6·68	0·28	0·06	7·58
Rajshahye	...	0·02	0·58	4·76	0·05	0·03	5·44
24-Pergunnahs	0·35	1·05	3·56	2·91	0·02	...	7·89
Howrah	0·17	0·60	3·54	2·10	0·09	...	6·50
Hooghly	0·86	0·69	3·63	0·89	...	0·04	6·11
Nuddea	0·19	0·13	2·28	3·00	0·10	...	5·70
Khoolna	0·27	0·67	4·50	3·83	2·39	0·61	12·27
Jessore	0·30	0·09	2·22	1·79	0 09	...	4·49
Chittagong	0·90	0·10	0·39	0 06	0·07	0·19	1·71
Chittagong Hill Tracts	0·04	0·07	0·12	...	0·13	...	0·36
Backergunge	0·10	1·81	3·57	1·74	0·97	0·06	8 25
Noakhally	...	1·55	1·04	0·97	0·63	0·33	4·52
Furreedpore	0·21	0 09	1·84	5·88	0·64	...	8·66
Dacca	0·29	1·00	1·13	3·71	0·87	0·11	7·11

Districts to the east of the storm centre.	13th.	14th.	15th.	16th.	17th.	18th.	Total.
Rungpore	...	0·01	1·49	4·69	2·57	0·04	8·80
Julpigoree	...	...	0·11	4·61	5·95	0·20	10·87
Cooch Behar	...	...	0·33	4·97	2·00	0·06	7·36
Darjeeling	...	...	0·02	6·46	5·71	0·36	12·55

Districts to the west of the path of the storm centre.	13th.	14th.	15th.	16th.	17th.	18th.	Total.
Patna	...	...	0·27	1·30	0·25	...	1·82
Monghyr	...	0·03	0·76	1·45	0·24	...	2·48
Sonthal Pergunnahs	...	0·38	1·38	1·25	0·82	...	3·83
Hazaribagh	...	0·36	1·63	0·78	0·03	...	2·80
Lohardugga	...	0·35	1·49	0·49	...	...	2·33
Manbhoom	0·07	0·30	2·18	0·72	...	...	3·27
Singhbhoom	0·18	0·08	2·35	0·94	...	...	3·55
Purneah	...	0·07	1·04	2·84	1·43	0·01	5·39
Bhaugulpore	...	...	0·46	2·46	0·65	0 01	3·58
Durbhanga	...	...	0·40	0·27	0 20	...	0·87
Mozufferpore	..	...	0·31	0·54	0·09	0 40	1·34
Champarun	...	...	..	...	...	...	...
Sarun	...	...	0·13	0·01	..	...	0·14
Shahabad	...	...	0·34	0·23	0·04	...	0·61
Gya	...	0·06	0·69	1·41	0·02	...	2·18

The preceding tables illustrate fully the large rainfall that occurred over the whole of Bengal during the storm. An average of about six inches fell in the districts through which the storm passed, and the districts to the east. The average fall of the districts to the west, which lay on the whole nearer to the centre than the districts to the east, was barely three inches.

The rainfall was distinctly greater over the districts to the east of the path of the centre, than it was in those through which the centre passed. The greatest district fall in the first list is that of Midnapore, but the centre either passed through the extreme western portion of that district, or did not enter it at all. If we transfer it to the second list, that list will then show that the districts of Mymensingh, Pubna, Bogra, Midnapore, 24-Pergunnahs, Howrah, Khoolna, Backergunj, Furreedpore, Dacca, Rungpore, Julpigoree, Cooch Behar, and the Darjeeling hills, all received a larger amount of rain than any of the districts through which it certainly passed. It is also proved by the fact that the great majority of the heaviest rainfalls in 24 hours occurred in the same districts, which were to the east of the path of the centre. A reference to Appendix B giving the rainfall at the sub-divisional stations in Bengal from the 1st to the 19th, will confirm this.

There were two centres of very heavy rainfall. One was in the Khoolna district, which received an average of 12·27 inches, due to unknown local conditions. The other was in and near the hills in North Bengal, in the Julpigoree, Cooch Behar, and Darjeeling Hill districts. The rainfall is, however, for obvious reasons, always excessive in these districts, in the case of a cyclone which advances into Northern Bengal.

APPENDIX A.

Storm Observations Recorded during the Cyclone of 16th and 17th October 1882 at Dhubri Meteorological Observatory.

October 1882.	Hour.	Reduced Reading Barometer.	Dry Bulb.	Wet Bulb.	Wind.		Cloud.		Rain.	General Weather.
					Velocity.	Direction.	Proportion of clouds.	Kind of cloud.		
16th	9—30	29·730	72·1	71·3	...	ENE & E	10	P	...	*o. g. r. q.*
,,	9—45	721	72·0	71·3	...	NE & ENE	10	P	...	*o. g. r. q.*
,,	10	713	71·9	70·7	27	NE & ENE	10	P	2·29	*o. g. r. q.*
,,	10—15	728	71·9	70·9	...	NE & ENE	10	P	...	*o. g. r, q.*
,,	10—30	722	71·9	71·2	...	NE & ENE	10	P	...	*o. g. r. q.*
,,	10—45	728	72·0	71·2	...	NE	10	P	...	*o. g, r. q.*
,,	11	710	72·0	71·3	36	NE & ENE & NNE	10	P	...	*o. r. q.*
,,	11 15	705	72·0	70·9	...	ENE & E & NE	10	P	...	*o. r. q.*
,,	11—30	687	71·4	70·3	...	NE & ENE & NNE	10	P	...	*o. r. q.*
,,	11—45	701	71·4	70·3	...	NE & ENE & NNE	10	P	...	*o. r. q.*
,,	12	673	71·5	70·3	45	NE & ENE & NNE	10	P	...	*o. r. q.*
,,	12—45	643	71·5	70·7	...	NE & ENE & NNE	10	P	...	*o. g. r. q.*
,,	13	655	71·6	70·7	39	E & ENE, NE & NNE	10	P	...	*o. g. r. q.*
,,	13—15	651	71·6	70·9	...	E & ENE, NE & NE	10	P	...	*o. g. r. q.*
,,	13—30	631	71·4	70·8	...	E & ENE, NE & NNE	10	P	...	*o. g. r. q.*
,,	13—45	639	71·4	70 6	...	ENE & NE, NE & NNE	10	P	...	*o. g. r. q.*
,,	14	632	71·2	70·4	38	ENE & NE & NNE	10	P	...	*o. g. r. q.*
,,	14—15	620	71·1.	70·5	...	ENE & NE & NNE	10	P	...	*o. g. r. q.*
,,	14—30	625	71·2	70·5	...	ENE & NE & NNE	10	P	...	*o. g. r. q.*
,,	14—45	621	71·1	69·8	...	ENE & NE & NNE	10	P	...	*o. g. r. q.*
,,	15	610	70·9	70·2	43	ENE & NE & NNE	10	P	...	*o g. r. q.*
,,	15—15	631	71·1	70·6	...	E & ENE, NE NNE & NNW	10	P	...	*o. g. r. q.*
,,	15—30	634	71·2	70·7	...	ENE & NE & NNE	10	P	...	*o. g. r. q.*
,,	15—45	622	71·2	70·6	...	N, NNE, ENE, E	10	P	...	*o. g. r. q.*
,,	16	616	71·1	70·6	41	ENE & NE & NNE	10	P	2·58	*o. g. r. q.*
,,	16—15	623	71·0	70·3	...	ENE & E & NE	10	P	...	*o. g. r. q.*
,,	16—30	645	71·0	70·3	...	ENE & E & NE	10	P	...	*o. g. r. q.*

October 1882.	Hour.	Reduced Reading Barometer.	Dry Bulb.	Wet Bulb.	Wind. Velocity.	Wind. Direction.	Cloud. Proportion of clouds.	Cloud. Kind of cloud.	Rain.	General Weather.
16th . .	17	651	70·3	69·3	38	NE & ENE & NNE	10	P	...	o. g. r. q.
,, . .	17—15	645	70·4	69·3	...	NE & ENE & NNE	10	P	...	o. g. r. q.
,, . .	17-30	655	70·1	69·0	...	NE & ENE & NNE	10	P	...	o. g. r. q.
,, . .	17—45	653	70·2	69·7	...	NE & ENE & E	10	P	...	o. g. r. q.
,, . .	18	663	70·4	69·8	40	NE & E, N & NW	10	P	0·62	o. g. r. q.
,, . .	18—15	631	70·2	69·3	...	ENE & NW	10	P	...	o. g. r. q.
,, . .	18—30	647	70·5	70·1	...	NE & NW	10	P	...	o. g. r. q.
,, . .	18—45	681	69·4	69·3	...	N & NW	10	P	...	o. g. r. q.
,, . .	19	690	69·9	69·6	36	NW to NE	10	P	...	o. g. r. q.
17th . .	9	777	70·1	69·1	...	NE & N & NW	10	P	...	o. g. r. q,
,, . .	9—30	788	70·1	69·1	...	NE & N & NW	10	P	...	o. g. r. q.
,, . .	10	775	69·1	68·7	33	NE & ENE	10	P	2·07	o. g. r. q.
,, . .	10—30	744	69·3	68·9	...	NE & N & NW	10	P	...	o. g. r. q.
,, . .	11	791	68 9	68·8	35	N & NW	10	P	1·11	o. g. d. q

Wind Velocity.

		Miles.			Miles.
17th	12 hrs	23	17th	18 hrs.	37
,,	13 ,, ...	31	,,	19 ,, ...	34
,,	14 ,, ...	31	,,	20 ,, ...	38
,,	15 ,, ...	31	,,	21 ,, ...	33
,,	16 ,, ...	31	,,	22 ,, ...	20
,,	17 ,, ...	42	,,	23 ,, ...	16

APPENDIX B.

Table of Rainfall recorded at Stations in Bengal in October 1882.

Divisions.	Stations.	First week. 1	2	3	4	5	6	7	Total rainfall of the week.	Second week. 8	9	10	11	12	13	14	Total rainfall of the week.	Third week. 15	16	17	18	19	Total rainfall for the month.
	Bengal.																						
	Burdwan District.																						
Burdwan.	Burdwan . . .	...	...	...	1·20	0·15	...	...	1·35	...	...	..	...	...	0·40	0·10	0·50	3·20	1·60	0·04	...	...	6·69
Burdwan.	Cutwa . . .	0·90	...	3·15	1·32	0·55	...	0·11	6·03	...	...	...	...	...	0·52	0·07	0·59	0·51	5·52	...	...	...	12·65
Burdwan.	Culna . . .	0·07	...	1·58	0·17	...	...	...	1·82	...	...	0·02	...	...	...	0·32	0·34	3·70	...	...	...	...	5·86
Burdwan.	Raneegunge . .	...	...	...	0·12	...	4·66	...	4·78	...	...	...	...	...	...	0·28	0·28	2·79	3·46	...	...	...	11·31

Table of Rainfall recorded at Stations in Bengal in October 1882—continued.

Divisions.	Stations.	First week.							Total rainfall of the week.	Second week.							Total rainfall of the week.	Third week.					Total rainfall for the month.
		1	2	3	4	5	6	7		8	9	10	11	12	13	14		15	16	17	18	19	
	Bengal—*contd.*																						
	Bankoora District.																						
Burdwan—*contd.*	Bankoora	...	...	...	...	...	...	...	*Nil*	...	...	...	...	...	0·36	0·46	0·82	2·92	2·04	0·15	...		5·93
	Bishenpore	...	...	0·33	0·52	...	...	...	0·85	...	...	...	.	...	0·14	0·38	0·52	4·00	0·17	..	. .		5·54
	Maliara	0·57	...	...	0·26	0·05	1·57	....	2·45		...	...	...	...	...	...	*Nil*	2·92	1·65	...	...	...	7·02
	Khatra	...	...	...	...	...	...	...	*Nil*	...	...	...	...	0·05	1·27	0·39	1·71	1·06	0·33	...		...	3·10
	Beerbhoom District.																						
	Soory	0·06	...	...	0·48	...	1·16	...	1·70	...	.	0·71	...	...	...	0·09	0·80	2·02	3·35	0·05	...	...	7·92
	Hitampore	0·14	...	0·88	1·67	...	. .	...	2·69	...	...	..	...	...	...	0·10	0·10	2·56	1·80	...	...	..	7·15
	Rampore Haut	...	..	1·40	0·67	...	...	...	2·07	...	...	...	...	...	0·25	0·85	1·10	4·10	1·06	0·50	0·06	..	8·89
	Midnapore District.																						
	Midnapore	...	...	...	0·47	...	...	...	0·47	...	...	...	...	0·29	0 39	2·73	3·41	2·76	0·03	..	...	...	6·77
	Tumlook	...	...	0·50	2·50	...	...	...	3·00	...	...	...	...	...	0·60	0·10	0·70	7·80	2·60	..	...	...	14·10
	Ghattal	...	...	0·45	0·18	0·13	...	...	0·76	...	...	...	..	...	...	0·52	0·52	4·74	...	...	...	...	...
	Contai	0·17	...	...	0·77	...	...	...	0·94	...	...	...	...	0·57	0·77	2·02	3·36	2·78	1·99	...	...	...	9·69
	Hooghly District.																						
	Hooghly	...	0·04	0·38	0·19	...	0·01	...	0·62	...	...	...	1·30	0·07	0·73	1·52	3·62	4·71	...	...	...	...	9·05
	Serampore	0·07	...	0·25	0·77	0·11	0·17	...	1·37	...	...	...	...	...	0 75	0·37	1·12	3·55	1·66	..	0 12	...	7·96
	Jehanabad	...	...	1·20	...	...	...	...	1·20	...	...	..	...	...	1·08	0·19	1·27	2·64	1·00	...	...	...	6·11
	Howrah District.																						
	Howrah	0·61	0·21	0·37	1·70	0·34	...	...	3·23	...	...	...	0·13	0·20	0 06	0·66	1·05	3·00	2·20	0·03	...	...	9·64
	Moheshreka	0·05	0·35	0·88	2·23	...	...	...	3·51	...	...	...	...	...	0·28	0·54	0·82	4·07	2·00	0·14	...	...	10·62
	24-Pergunnahs.																						
Presidency.	Saugor Island	...	...	...	1·12	...	...	...	1·12	...	...	...	...	...	0·90	3·91	4·81	3·12	0·90	0·05	...	...	12·13
	Alipore (Jail)	0·70	0·35	0·25	0·10	...	...	...	1·40	...	...	...	...	...	0·90	2·00	2·90	2·20	0·15	...	...	...	6·65
	Busseerhat	0·07	0·11	0·15	...	...	0·25	...	0·58	...	...	...	0·07	...	0·15	0·71	0·93	4·28	7·70	...	...	...	13·54
	Baraset	...	...	0·08	...	0·15	...	...	0·23	...	...	...	...	0·35	...	0·68	1·03	4·00	5·11	0·08	...	...	10·45
	Diamond Harbour	...	...	1·09	1·20	0·01	...	...	2·30	...	...	...	...	0·43	0·33	0·28	1·04	4·50	1·05	...	...	...	9·28
	Barripore	1·95	0·45	1·00	0·72	...	...	...	4·12	...	...	...	...	...	...	...	*Nil*	1·04	7·38	...	...	...	12·68
	Barrackpore	...	...	0·10	0·06	0·10	0·26	...	0·52	...	...	0·25	...	...	0·40	0·25	0·90	2·00	1·00	.	...	...	4·51
	Dum-Dum	...	...	0·22	0·70	0·12	0·02	...	1·06	...	...	...	0 54	...	0·09	0·56	1·19	7·30	...	...	...	...	9·67
	Nuddea District.																						
	Kishnaghur	...	...	0·98	1·69	...	...	...	2·67	...	...	...	...	1·19	0·25	0·69	2·13	3·59	0·15	...	...	...	8·54
	Bongong	...	...	...	...	1·55	0·65	...	2·20	...	...	...	0·70	0·44	...	...	1·14	2·72	3·85	...	...	...	9·91
	Meherpore	0·02	...	0·79	0·03	0·56	0·17	...	1·57	...	...	...	...	...	...	...	*Nil*	3·15	2·55	0·11	...	...	7·38
	Chooadanga	...	...	1·07	...	0·63	...	...	1·70	...	..	...	...	...	0·53	0·06	0·59	2·71	3·24	0·19	...	...	8·43
	Kooshtea	...	...	3·38	0·19	0·83	...	...	4·40	...	..	...	...	...	...	...	*Nil*	1·52	4·46	...	...	...	10·38
	Ranaghat	...	...	...	3·65	...	0·38	...	4·03	...	...	...	...	...	0·35	...	0·35	...	3·75	0·29	...	...	9·72

Table of Rainfall recorded at Stations in Bengal in October 1882—continued.

Divisions.	Stations.	First week.							Total rainfall of the week.	Second week.							Total rainfall of the week.	Third week.					Total rainfall for the month.
		1	2	3	4	5	6	7		8	9	10	11	12	13	14		15	16	17	18	19	
	BENGAL—*contd.*																						
	Jessore District.																						
Presidency—*contd.*	Jessore	...	...	0·33	0·22	0·31	0·06	...	0·92	...	...	...	...	0·14	...	0·16	0·30	3·68	2·70	0·35	...	...	7·95
	Narail	...	0·31	0·47	0·45	0·65	0·13	...	2·05	...	...	...	...	...	0·23	0·09	0·32	1·30	...	...	...	...	3·67
	Jhenida	...	...	1·21	0·41	0·14	...	...	1·76	...	...	...	...	...	0·26	0·04	0·30	1·97	2·91	...	...	...	6·94
	Magoora	...	...	0·08	1·43	0·67	...	...	2·18	...	...	...	...	...	0·69	0·05	0·74	1·93	1·53	...	...	...	6·38
	Khoolna District.																						
	Khoolna	...	0·50	0·22	0·65	...	0·42	...	1·79	...	...	...	...	...	0·24	0·10	0·34	4·05	2·45	..	...	...	8·63
	Bagirhat	...	...	0·11	0·15	0·25	0·25	...	0·76	...	...	...	...	...	0·56	0·40	0·96	5·50	6·90	6·70	1·84	1·40	24·58
	Satkhira	...	0·15	0·40	0·18	...	0·91	...	1·64	...	...	...	0·10	0·82	...	1·52	2·44	3·95	2·15	0 48	...	...	10·66
	Moorshedabad District.																						
	Berhampore	0·35	0·90	0·10	0·36	0·65	...	...	2·36	...	...	...	...	...	0·15	0·35	0·50	3·23	3·68	...	...	...	9·77
	Lalbagh	...	0·27	...	0·14	...	0·51	...	0·92	...	...	...	...	...	...	...	*Nil*	3·28	3·69	...	...	...	7·89
	Jungypore	...	0·16	0·50	0·40	0·71	...	...	1·77	...	...	...	...	...	...	...	*Nil*	0·67	3·00	0·15	0·06	...	5·62
	Azimgunge	0·05	...	0·30	0·02	0·65	...	...	1·02	...	...	...	...	...	0·90	0·03	0·93	4·82	2·85	...	...	...	9·62
	Lalgola	...	...	0·64	0·70	0·02	0·39	...	1·75	...	...	...	...	...	0·02	0·70	0·72	4·60	0·25	0·04	0·02	...	7·38
	Kandi	1·50	...	0·04	1·06	0·44	...	0·16	3·20	...	...	...	...	...	...	0·34	0·34	0·61	3·10	0·10	0·06	...	7·41
	Dinagepore District.																						
	Dinagepore	0·20	0·10	5·05	1·50	0·02	0·21	...	7·08	...	...	...	...	..	...	0·05	0·05	4·25	...	0·09	...	...	15·82
	Raigunge	...	...	0·32	0·48	...	...	...	0·80	...	...	...	...	...	...	...	*Nil*	2·51	2·93	0·15	...	...	6·39
	Mohadebpore	1·50	...	0·40	1·00	0·60	0·50	0·50	4·50	...	...	...	...	...	...	...	*Nil*	0·06	3·33	0·75	...	...	8·64
	Chooramun	...	...	0·12	0·48	0·05	...	...	0·65	...	...	...	...	...	...	...	*Nil*	0·55	4·20	0·22	...	...	5·62
	Baloorghat	0·22	...	1·02	1·55	0·07	1·12	...	3·98	...	...	...	...	...	...	...	*Nil*	4·52	4·76	0·06	...	...	13·32
	Malda District.																						
	Malda	...	0·08	0·09	0·19	0·03	...	0·41	0·80	...	...	0·07	...	...	...	0·04	0·11	0·44	3·63	0·19	0·06	...	5·23
Rajshahye.	*Rajshahye District.*																						
	Bauleah	0·02	...	0·10	1·02	0·23	0·18	0·03	1·58	...	...	...	...	...	...	0·03	0·03	0·96	4·51	0·09	0·06	...	7·23
	Nattore	...	0·20	0·30	1·30	...	0·50	0·15	2·45	...	...	...	...	...	...	...	*Nil*	0·20	5·00	...	...	...	7·65
	Rungpore District.																						
	Rungpore	...	...	0·99	0·71	0·04	0·03	0·08	1·85	...	...	...	...	...	...	0·02	0·02	0·02	8·88	3·53	...	...	14·30
	Bhabanigunge	1·32	...	1·62	...	3·97	...	0·24	7·15	...	...	...	...	...	...	...	*Nil*	4·85	2·19	1·64	...	0·11	15·94
	Kurigram	0·12	0·43	...	1·94	2·15	0·25	...	4·89	...	...	...	...	...	...	...	*Nil*	0·90	2·20	3·00	0·10	...	11·09
	Bagdogra	0·10	...	0·05	2·50	0·05	...	...	2·70	...	...	...	...	...	...	...	*Nil*	0·20	5·50	2·10	0·06	0·20	10·76
	Bogra District.																						
	Bogra	1·16	...	0·31	0·35	0·97	...	...	2·79	...	...	...	...	...	...	0·28	0·28	0·36	4·89	0·23	0·10	0·13	8·78
	Sherpore	0·70	...	0·30	1·50	0·90	...	...	3·40	...	...	...	...	...	...	...	*Nil*	0·50	6·80	...	...	..	10·70
	Nowkhila	1·42	...	0·22	4 06	1·62	...	...	7·32	...	...	...	...	...	...	...	*Nil*	0·85	7·82	0·16	...	...	16·15
	Panchbibi	1·00	...	0·03	1·28	1·20	0·20	...	3·71	0·38	...	...	...	...	...	...	0·38	0·26	7·19	0·74	0·12	..	12·40

Table of Rainfall recorded at Stations in Bengal in October 1882—continued.

Divisions.	Stations.	First week. 1	2	3	4	5	6	7	Total rainfall of the week.	Second week. 8	9	10	11	12	13	14	Total rainfall of the week.	Third week. 15	16	17	18	19	Total rainfall in the month.
	BENGAL—*contd.*																						
	Pubna District.																						
Rajshahye —*contd.*	Pubna	...	...	2·10	0·56	0·57	0·08	..	3·31	...	...		...	..	...	...	*Nil*	1·30	4·15	...	..		8·76
	Serajgunge	...	...	...	1·20	2·10	0·10	...	3·40	..	...		...	...	...	...	*Nil*	0·16	8·90	0·30	0·10	...	12·86
	Darjeeling District.																						
Cooch Behar.	Darjeeling	...	...	..	1·33		0·03	...	1·36	...		.	...	...	...		*Nil*	...	7·59	6·27	0·44	...	15·84
	Kalimpong	0·38	...	1·80	0·62	...	...	...	2·80	...	...		...	...	...	...	*Nil*	0·04	5·32	5·15	0·27	...	14·00
	Julpigori District.																						
	Julpigoree	...	2·16	0·41	3·43	...	.	...	6·00	0·15	...	...	...	...	...	...	0·15	0·22	3·47	6·93	...	...	18·46
	Buxa	1·50	7·90	3·10	3·25	0·05	...	...	15·80	0·10	0·40	0·30	0·02	0·30	...	..	1·12	...	5·75	4·96	0·40	1·05	29·43
	Cooch Behar Tributary States																						
	Cooch Behar	0·12	2·84	0·50	7·32	0·10	...	...	10·88	...	...	...	...	...	..	...	*Nil.*	0·30	4·75	0·10	...	...	16·69
	Dinhatta	0·04	0·12	0·72	5·95	0·48	0·45	...	7·76	...	...	...	...	...	..	...	*Nil.*	0·41	6·12	1·95	0·07	...	18·03
	Matabhanga	0·09	2·50	0·63	6·54	...	...	...	9·76	...	...	.	...	...	...	...	*Nil.*	0·28	5·27	2·31	0·05	...	19·15
	Meckligunge	..	1·40	0·18	2·60	1·50	0·40	...	6·08	...	...	...	...	...	...	...	*Nil.*	0·31	3·72	3·63	0·11	...	15·59
	Dacca District.																						
Dacca.	Dacca	...	...	0·19	1·45	0·07	...	...	1·71	...	...	...		...	0·04	1·22	1·26	1·00	2·82	0·70	0·04	...	7·53
	Moonsheegunge	...	...	1·48	2·24	...	...	...	3·72	...	...	...	...	...	0·84	1·70	2·54	1·54	2·82	1·90	0·30	...	12·82
	Manickgunge	0·10	...	0·70	0·22	0·22	...	..	1·24	...	...	...	...	..	...	0·08	0·08	0·85	5·50	...	...	...	7·67
	Furreedpore District.																						
	Furreedpore	...	...	1·02	0·76	0·16	0·06	...	2·00	...	...	...	.	...	...	...	*Nil.*	1·41	9·87	0·28	...	...	13·56
	Gopalundo	0·05	0·45	1·05	0·95	...	...	...	2·50	...	...	...	...	...	0·15	...	0·15	1·00	5·12	0·50	...	...	9·27
	Madaripore	0·15	0·21	0·35	0·19	...	...	0·21	1·11	...	...	...	...	0·89	0·49	0·28	1·66	3·12	2·65	1·13	...	...	9·98
	Backergunge District.																						
	Burrisal	0·52	0·01	0·39	1·03	0·03	...	0·12	2·10	...	...	...	...	...	0·04	1·02	1·06	4·28	1·20	0·32	0·03	...	9·06
	Perozepore	...	...	...	1·00	0·65	...	...	1·65	...	...	...	...	...	0·35	2·59	2·94	5·10	3·08	2·60	...	...	15·37
	Patuakhally	...	...	0·80	0·70	0·25	...	...	1·75	...	...	...	...	...	...	3·20	3·20	4·65	1·35	0·95	0·20	0·16	12·26
	Bhola	0·35	0·20	1·27	3·22	0·43	...	...	5·47	...	...	...	...	...	...	0·41	0·41	0·26	1·34	...	...	0·45	8·45
	Mymensingh District.																						
	Mymensingh	0·70	...	2·30	1·76	1·34	0·96	0·08	7·14	...	...	...	...	...	...	...	*Nil.*	0·55	3·47	3·50	...	...	14·66
	Jamalpore	0·64	...	0·48	1·90	1·01	0·16	...	4·19	...	...	...	...	...	...	...	*Nil.*	0·74	6·80	0·85	...	...	12·58
	Atia	...	...	0·09	2·86	...	...	...	2·95	...	...	...	...	...	...	...	*Nil.*	4·12	9·72	0·72	...	...	17·51
	Kishoregunge	0·11	0·29	0·46	1·14	0·66	0·17	...	2·83	...	...	...	...	...	...	0·09	0·09	0·56	0·76	1·06	...	...	5·30
	Nitrokona	...	0·07	1·00	0·87	3·48	1·84	0·54	7·80	...	...	...	...	...	...	...	*Nil.*	3·00	0·60	0·53	0·10	...	12·04

Table of Rainfall recorded at Stations in Bengal in October 1882—continued.

Divisions.	Stations.	First week.							Total rainfall of the week.	Second week.							Total rainfall of the week.	Third week.					Total rainfall of the month.
		1	2	3	4	5	6	7		8	9	10	11	12	13	14		15	16	17	18	19	
	BENGAL—*contd.*																						
	Chittagong District.																						
Chittagong	Chittagong	...	0·03	0·23	0·16	2·06	...	...	2·48	...	...	...	...	...	0·03	...	0·03	0·05	0·12	0·14	0·37	0·92	5·35
	Cox's Bazar	0·24	...	1·00	0·30	0·50	0·16	...	2·20	...	...	...	...	0·27	1·76	0·20	2·23	0·72	...	...	...	...	5·30
	Noakhally District.																						
	Noakhally	...	0·91	0·91	2·82	0·22	...	...	4·86	...	...	...	...	...	...	2·78	2·78	1·38	1·22	0·38	...	...	10·62
	Fenny	...	0·80	1·05	1·02	1·09	0·14	0·20	5·30	...	...	...	...	...	...	0·31	0·31	0·69	0·72	0·88	0·65	0·15	8·91
	Tipperah District.																						
	Commillah	...	0·01	0·15	1·04	1·37	...	...	2·57	...	...	...	...	...	...	0·23	0·23	0·49	0·65	...	0·75	...	4·69
	Chandpore	0·75	2·10	3·85	2·50	0·60	...	...	9·80	...	...	...	...	0·25	0·70	1·15	2·10	1·20	2·10	1·75	0·75	...	17·70
	Brahmunberiah	...	...	0·86	1·58	1·60	...	...	4·04	...	...	...	...	...	...	0·40	0·40	0·90	1·40	0·20	0·08	...	7·02
	Chittagong Hill Tracts.																						
	Rangamatee Hill	...	...	0·16	0·04	1·05	0·03	...	1·28	...	...	...	...	...	...	0·06	0·06	0·04	...	0·25	...	0·14	7·04
	Ruma	0·28	...	0·37	...	0·01	...	...	1·46	...	...	...	2·17	0·20	0·08	0·08	2·53	0·20	...	...	...	...	4·41
	Hill Tipperah District.																						
	Agurtola	1·68	0·27	0·15	0·75	1·10	...	...	3·95	...	...	...	...	...	...	0·86	0·86	0·30	0·70	1.03	0·74	...	7·58
	BEHAR.																						
	Patna District.																						
Patna	Patna	...	...	3·61	0·09	0·14	...	0·07	3·91	...	..	...	...	...	...	..	*Nil.*	0·21	1·04	0·34	...	...	5·50
	Behar	0·16	...	1·16	0·06	0·05	...	...	1·43	...	...	...	...	...	...	...	*Nil.*	0·69	2·29	0.05	...	...	4·46
	Barh	...	...	1·23	0·27	0·27	...	...	1·77	...	...	...	...	...	...	...	*Nil.*	...	1·55	0·49	...	...	3·81
	Dinapore	...	..	2·85	...	...	...	0·20	3·05	...	...	...	...	...	...	...	*Nil.*	0·17	0·30	0·10	...	...	3·62
	Gya District.																						
	Gya	...	...	0·29	0·10	0·32	...	...	0·71	...	...	...	..	...	...	0·22	0·22	0·37	2·20	0·07	...	...	3·57
	Nowadah	...	...	2·11	0·34	0·03	...	...	2·48	...	...	...	...	...	...	...	*Nil.*	0·59	2·14	...	...	...	5·21
	Aurungabad	...	...	1·30	...	...	...	...	1·30	...	...	...	...	...	...	...	*Nil.*	1·00	0·81	...	...	...	3·11
	Jehanabad	...	...	1·60	0·14	...	...	...	1·74	...	...	...	...	...	...	...	*Nil.*	0·78	0·50	...	...	...	4·02
	Shahabad District.																						
	Arrah	...	...	2·96	0·83	0·18	...	0·12	4·09	...	...	...	...	...	...	...	*Nil.*	0·20	0·12	...	...	...	4·41
	Sasseram	2·36	...	1·77	0·50	0·50	...	..	5·13	...	...	...	..	...	...	...	*Nil.*	0·16	0·79	0·16	...	...	6·24
	Buxar	...	...	2·54	0·10	...	...	...	2·64	...	...	...	...	...	...	...	*Nil.*	0·06	...	...	...	...	2·70
	Bhubooah	0·30	0·20	7·30	...	...	...	...	7·80	...	...	...	...	...	...	...	*Nil.*	0·95	...	...	...	...	8·75
	Muzufferpore District.																						
	Mozufferpore	...	0·36	1·62	...	...		...	1·98	...	...	...	...	.	...	...	*Nil.*	0·80	0·42	...	...	...	3·20
	Hajeepore	...	...	4·43	...	0·13	...	0·20	4·76	...	...	...	...	...	...	...	*Nil.*	0·13	1·19	0·27	...	...	6·35
	Seetamurhee	...	...	1·69	1·20	...	...	...	2·89		..	...	...	...	...	...	*Nil.*	...	...	...	1·20	...	4·09

Table of Rainfall recorded at Stations in Bengal in October 1882.

Division.	Stations.	First week.							Total rainfall of the week.	Second week.							Total railfall of the week.	Third week.					Total rainfall for the month.
		1	2	3	4	5	6	7		8	9	10	11	12	13	14		15	16	17	18	19	
	BEHAR—*contd.*																						
	Durbhunga District.																						
PATNA—contd.	Durbhunga	...	...	2·40	...	0·30	...	...	2·70	...	...	...	...	...	...	...	*Nil.*	...	...	...	...	...	2·70
	Mudhoobunny	...	...	0·30	0·40	0·05	...	...	0·75	...	...	...	...	...	...	...	*Nil.*	0·21	0·19	0·23	...	..	1·38
	Tajpore	0·05	0·04	0·60	...	0·04	...	...	0·73	...	...	...	...	...	...	...	*Nil.*	1·00	0·63	0·37	...	...	2·73
	Sarun District.																						
	Chupra	...	...	2·93	0·47	...	...	0·15	3·55	...	...	...	...	...	...	...	*Nil.*	0·16	...	...	...	...	3·71
	Sewan	...	...	8·48	2·07	...	...	...	10·55	...	...	...	...	...	...	...	*Nil.*	0·11	0·02	...	...	...	10·68
	Gopalgunge	...	...	22·02	0·76	...	...	0·10	22·88	...	...	...	...	...	...	...	*Nil.*	0·12	...	...	...	...	23·00
	Chumparun District.																						
	Mothiharee	...	...	4·62	8·23	...	...	0·23	13·08	...	...	...	...	...	...	...	*Nil.*	...	...	...	...	...	13·08
	Bettia	...	...	11·80	4·45	...	...	..	16·25	...	...	...	...	...	...	...	*Nil.*	...	...	...	...	...	16·25
	Monghyr District.																						
BHAGULPORE.	Monghyr	...	...	0·55	0·03	0·03	...	...	0·61	...	...	...	...	...	...	...	*Nil.*	1·55	1·84	0·04	...	...	4·04
	Begooserai	...	...	...	...	...	...	...	*Nil.*	...	...	...	...	...	...	...	*Nil.*	0·30	1·38	0·64	...	..	2·32
	Jamooee	...	...	...	1·50	0·92	0·31	...	2·73	...	...	...	...	...	..	0·10	0·10	0·42	1·12	0·04	...	...	4·41
	Bhagulpore District.																						
	Bhagulpore	...	...	0·14	0·38	0·17	...	...	0·69	...	...	...	...	...	...	...	*Nil.*	0·06	2·61	0·46	0·03	...	3·85
	Soopole	0·57	...	0·02	0·86	...	...	...	1·45	...	...	...	...	...	...	...	*Nil.*	0·41	1·61	0·60	...	...	4·07
	Muddehpoora	...	...	0·26	0·55	...	...	...	0·81	...	...	...	...	...	...	...	*Nil.*	0·65	3·05	1·55	...	...	6·06
	Banka	...	...	...	0·30	0·25	...	...	0·55	...	...	...	...	...	...	...	*Nil*	0·70	2·55	...	...	...	3·80
	Purneah District.																						
	Purneah	0·90	..	0·16	0·36	...	...	...	1·42	...	...	...	...	...	...	...	*Nil*	0·23	3·35	1·23	0·03	...	6·26
	Kissengunge	...	...	0·62	1·35	...	...	...	1·97	..	...	...	...	...	...	...	*Nil*	2·70	2·90	0·50	...	...	8·07
	Arrareah	...	...	0·50	3·00	...	...	...	3·50	...	...	...	...	...	...	0·22	0·22	0·20	2·26	2·56	...	...	8·74
	Sonthal Pergunnahs District.																						
	Nya Doomka	...	...	0·33	0·19	0·05	1·28	...	1·85	...	...	...	...	...	...	1·18	1·18	1·18	1·28	3·60	...	0·02	9·11
	Rajmehal	0·25	0·05	...	0·40	0·07	...	...	0·77	...	...	...	...	...	...	...	*Nil*	1·24	1·80	0·20	...	...	4·01
	Deoghur	...	..	...	1·33	0·12	0·15	...	1·60	...	...	...	...	...	...	0·16	0·16	1·25	2·09	0·38	..	...	5·48
	Jamtara	...	...	0·37	2·82	0·95	0 06	...	4·20	...	...	...	...	...	...	0·43	0·43	...	...	...	...	...	4·63
	Pakour	...	...	0·34	0·21	...	0·04	...	0·59	...	...	...	...	...	...	0·50	0·50	3·70	0·25	0·65	...	...	5·69
	Godda	...	.	0·28	...	0·25	...	...	0·53	...	...	...	...	...	...	...	*Nil*	0·88	2·06	0·08	...	...	3·55
	ORISSA.																						
	Cuttack District.																						
ORISSA.	Cuttack	0·66	0·06	0·91	0·12	...	...	...	1·75	...	0·93	...	...	...	0·50	1·06	2·49	3·30	0·03	...	...	...	7·64
	Jajpore	...	...	0·75	...	...	...	...	0·75	...	...	...	...	...	1·43	1·95	3·38	1·86	0·30	...	...	...	6·69
	Kendrapara	...	...	...	...	...	...	...	*Nil*	...	...	...	...	0·40	3·00	2·50	5·90	2·20	...	...	...	...	12·50

Table of Rainfall recorded at Stations in Bengal in October 1882—continued.

Division.	Stations.	First week.							Total rainfall of the week.	Second week.							Total rainfall of the week.	Third week.					Total rainfall for the month.
		1	2	3	4	5	6	7		8	9	10	11	12	13	14		19	16	17	18	19	
Orissa—contd.	*Cuttack District*—contd.																						
	Jagatsingpore	...	...	0·30	...	...	...	...	0·30	...	..	...	...	...	3·20	1·60	4·80	0·40	...	...	0·10	...	8·80
	False Point	...	0·13	...	0·05	...	0·09	...	0·27	...	...	...	..	...	1·40	3·64	5·04	0·21	0·50	...	...	...	8·25
	Banki	...	0·40	0·10	0·70	...	...	...	1·20	...	0·30	...	...	..	0·30	0·80	1·40	3·10	...	...	...	...	6·00
	Pooree District.																						
	Pooree	0·08	...	0·18	0·67	...	...	0·19	1·12	...	...	...	...	...	2·25	1·60	3·85	0·75	...	...	...	0·74	7·95
	Khurdah	...	0·24	1·35	0·65	...	...	...	2·24	...	...	...	0·16	0·16	0·68	1·10	2·10	4·54	0·03	...	...	...	9·41
	Banpore	0·07	...	0·12	.	...	...	...	0·19	...	...	0·07	0·25	0·17	0·62	0·68	1·79	...	...	...	...	...	4·57
	Balasore District.																						
	Balasore	...	...	0·20	0·53	0·11	...	..	0·84	...	...	...	...	...	0·83	4·78	5·61	2·69	0·03	...	...	...	10·10
	Bhuddruck	0·12	...	...	0·25	...	...	...	0·37	...	...	...	...	0·92	1·00	3·42	5·34	2·42	...	...	...	...	8·70
	Jellapore	...	...	0·20	1·40	...	...	...	0·60	...	...	...	0·50	...	1·10	1·29	2·89	...	...	...	...	...	4·89
	Sorah	...	...	...	0·20	...	...	...	0·20	...	...	...	...	...	3·47	4·47	7·94	0·32	...	...	...	0·11	8·85
	Chandbally	..	...	0·36	0·50	...	...	...	0·86	...	...	...	...	0·90	4·48	1·26	6·64	0·15	...	...	...	...	9·45
	Bareepudda	0·04	...	0·15	...	0·26	...	...	0·45	...	...	...	...	...	0·45	0·89	1·34	4·44	0·16	0·05	...	...	6·47
	Chota Nagpore.																						
	Hazaribagh District.																						
	Hazaribagh	0·04	...	0·15	0·24	0·09	...	...	0·52	...	...	...	...	...	...	0·69	0·69	1·20	1·50	0·15	...	...	4·06
	Pachamba	...	...	..	...	0·50	...	...	0·50	...	...	...	...	...	...	0·65	0·65	1·10	1·02	...	...	...	3·27
	Seetaghurh	...	...	0·25	0·10	...	...	...	0·35	...	...	...	...	...	...	0·20	0·20	2·32	0·28	...	...	...	3·15
	Mowdie Hills	...	...	1·11	...	...	...	...	1·11	...	...	...	...	...	...	0·28	0·28	1·51	0·06	...	...	...	2·96
	Jhoonrah Hills	...	...	0·80	...	0·40	..	...	1·20	...	...	...	..	...	...	...	*Nil*	2·03	1·02	...	...	...	4·25
	Lohardugga District.																						
	Ranchee	0·20	0·12	0·10	0·10	...	...	...	0 52	...	...	...	...	...	...	0·60	0·60	2·72	0·25	...	...	...	4·00
	Palamow	0·12	...	...	...	...	...	...	0·12	...	...	...	...	...	...	0·10	0·10	0·25	0·73	...	...	...	1·20
	Singhbhoom District.																						
	Chyebassa	...	...	0·48	0·30	...	...	...	0·78	...	...	...	...	...	0·18	0·08	0·26	2·35	0·94	...	...	...	4·33
	Manbhoom District.																						
	Purulia	...	...	...	0·02	...	...	...	0·02	...	0·12	...	...	...	0·07	0·24	0·43	2·65	0·76	...	...	...	3·86
	Gobindpore	0·02	...	...	0·17	0·01	...	...	0·20	...	...	...	...	...	0·06	0·36	0·42	1·70	0·68	...	...	...	3·00

APPENDIX C.

A Report on the weather at the False Point Light-house from the 10th to the 16th of October 1882.

Tuesday, 10th.—Commenced with light north and north-west winds, a clear sky, and fine weather. Wind increased to a moderate breeze during the day with light passing clouds. Towards evening the wind hauled to the north-east, and died away to light winds and calms during the night.

Wednesday, 11th.—Commenced with light winds, clear sky, and light hazy weather. The haze cleared up about 8 A.M., and the wind from the north and north-east remained light, and the weather fine and clear, during the remainder of the day and night.

Thursday, 12th.—Commenced with light north and north-east winds, clear sky, and fine weather. The wind increased during the day to moderate and fresh breezes, and to strong and squally, with showers of rain, during the night.

Friday, 13th.—Commenced with strong north-east winds and squally with showers of rain, and heavy banks of clouds rolling up from the east and north-east; 6 A.M., the weather having a very threatening appearance, and the squalls blowing rather heavy, I commenced taking two hourly observations of the barometer (the observations are given below), but as yet that instrument showed no indication of bad weather. As the weather had a very nasty appearance, and the sea was beginning to rise, I thought it advisable to continue the observations. About noon, the wind increased to a gale, blowing in heavy gusts, with a thick and heavy overcast sky, and showers of rain. The gale continued blowing with the same force, and the weather the same until 8 P.M., when it began to moderate a little, but still blowing in heavy squalls. 10 P.M. Moderate north-east winds with a heavy overcast sky, dark gloomy weather, and heavy showers of rain. Midnight, the wind freshened again, and the weather had a very threatening appearance, so that it was evident the gale had not passed as yet.

Saturday, 14th.—Blowing a strong breeze with squalls; heavy overcast sky, and distant thunder and lightning. At 6 A.M., the wind veered round to the south-east, and was blowing in heavy squalls, and the weather had a very threatening appearance. Noon, the squalls were heavier than ever, and the weather looked very ugly, with heavy showers of rain; the sea in the Bay was running very high, and the surf on the beach abreast the Light-house was very heavy. As there was no signs of it clearing up, and the barometer was steadily falling, I had all the boats brought into the small creek, and had them, and everything about the Light-house, made as secure as possible. 6 P.M., the wind still from the south-east increased to a gale again, and blew very hard up to midnight with very heavy gusts, distant thunder and lightning, showers of rain, and very ugly weather. The tide this night was the highest of the year; it was high water about 11 P.M., and it rose at least one foot higher than any other tide during the year.

Sunday, 15th.—Gale still blowing as furious as ever, and the weather had the same ugly appearance until 3 A.M., when it began to moderate, and the squalls were neither so frequent, nor so fierce. At 4 A.M. the wind had veered round to the south, blowing a fresh breeze with an overcast sky and squally, but the weather had lost a great deal of its threatening appearance. At 6 A.M. the wind was at south-west, and was blowing strong with smart squalls, but the sky began to clear up a little, and patches of blue began to show out. It was now evident that the gale had passed. It, however, continued to blow strongly from the south-west with smart squalls during the day and night. At 8 P.M. we had a very severe squall from S.-W. with heavy thunder and lightning; it lasted only for a few minutes, but while it lasted, it made everything about the light-house shake again. It was heavier than any of the squalls we had during the gale.

Monday, 16th.—Commenced with strong and fresh south-west winds, an overcast sky and thick muggy weather. At 8 A.M. the wind moderated, and the weather began to clear up. Noon, moderate south-west winds, cloudy and fine. Towards evening light south-west winds, with a light overcast sky and fine weather which continued during the night.

READINGS OF THE BAROMETER AT THE FALSE POINT LIGHT-HOUSE FROM THE 10TH TO THE 16TH OF OCTOBER 1882.

Tuesday, 10th.

Hours.	Barometer.	Attached Thermometer.	Winds.	Rainfall.	Remarks.
10	29·992	85·0	N	*Nil.*	Moderate breeze, passing clouds and fine.
16	29·850	86·8	N E	*Nil.*	Ditto wind and weather.
			Wednesday, 11th.		
10	29·964	85·0	N	*Nil.*	Light winds, clear and fine weather.
16	29·863	86·9	N E	*Nil.*	Ditto weather with passing clouds.
			Thursday, 12th.		
10	29·988	86·0	N N E	*Nil.*	Moderate breeze, passing clouds and fine.
16	29·892	85·7	N E	*Nil.*	Fresh breeze and ditto weather.
			Friday, 13th.		
6	29·910	81·0	N E	0·08	Strong breeze and squally with heavy clouds rolling up from the east and north-east and showers of rain, the weather having a threatening appearance.
8	29·948	82·2	E N E	*Nil.*	Ditto weather.
10	29·936	81·0	E N E	0·34	Ditto weather with showers of rain.
12	29·904	82·7	E N E	*Nil.*	Wind increased to a gale, and blowing in heavy gusts.
14	29·840	81·9	N E	0·07	Gale still blowing with a heavy overcast sky and fierce squalls.
16	29·812	79·7	E	0·62	Gale still blowing, and dark gloomy weather.
18	29·834	79·1	E N E	0·29	Gale moderating a little, but still blowing strong in squalls; a heavy overcast sky and showers of rain.
20	29·870	80·0	E N E	0·47	Ditto weather, wind moderating a little.
22	29·872	79·6	N E	0·48	Moderate breeze, an overcast sky, and dark gloomy weather.
24	29·838	78·7	E N E	0·04	Fresh breeze and similar weather.
			Saturday, 14th.		
2	29·776	80·0	ENE	...	Strong breeze and squally with a heavy overcast sky and distant thunder and lightning.
4	29·750	80·1	ENE	0·10	
6	29·758	79·8	SE	0·29	
8	29·768	80·0	SE	0·18	
10	29·752	79·6	SE	0·11	
12	29·712	79·6	SSE	1·15	Wind blowing in very heavy squalls with heavy showers of rain, and ugly looking weather.
14	29·698	81·2	SSE	0·55	Wind increasing, and the squalls more frequent; a thick heavy overcast sky.

Hours.	Barometer.	Attached Thermometer.	Winds.	Rainfall.	Remarks.
16	29·598	81 0	SE	0·18	
18	29·558	81·2	SE	0·09	Blowing a gale of wind, squalls very heavy and a thick and low overcast sky.
20	29·594	82·0	SE	*Nil*	
22	29·626	81·4	SE	0·05	
24	29·616	81·4	SE	0·03	Weather with thunder and lightning.
			Sunday, 15th.		
2	29·588	80·0	S	0·09	Gale still blowing as hard as ever until 3 A. M., when it began to moderate.
4	29·600	80 0	S	*Nil*	Fresh breeze and squally, an overcast sky and thunder and lightning.
6	29·608	80·2	SW	0·04	Strong breeze and squally and an overcast sky.
8	29·652	80·6	SW	*Nil*	Similar weather, but the squalls not so frequent or so heavy, and the clouds are beginning to break, and patches of blue sky to show out.
10	29·690	81·2	SW	*Nil*	
12	29·650	83·0	SW	*Nil*	As it is quite evident now that the gale is passed, I discontinued taking the two hourly observations from this time.
16	29·588	83·0	SW	*Nil*	At 8 P. M. a very severe squall from the south-west with thunder, heavy lightning, and rain. Strong south-west winds and squally during the night.
			Monday, 16th.		
10	29·812	82·0	WSW	0·50	Moderate breeze, cloudy sky, and fine weather.
16	29·782	83·0	SW	*Nil*	Light winds, an overcast sky and fine.

The above readings are all taken from the standard barometer supplied by the Meteorological Reporter to the Government of Bengal, (the index error of which to the Calcutta standard is +·011), and can be depended upon as being correct.

LIGHT-HOUSE, FALSE POINT,
The 6th November 1882.

EDWIN WORKMAN,
Light-house Keeper, False Point.

APPENDIX D.

Extract from the Log-book of Cowcolly Light-house regarding the weather from the 10th to 16th October 1882.

10th October 1882.—At 6-5 A.M., thermometer 83°, wind a calm, weather fine but slightly hazy; at 11 A.M., weather fine with a few scattered clouds, wind light, north-west; at 3 P.M., weather fine, wind light north-west; at 5-55 P.M., thermometer 92°, wind a dead calm, weather fine but very sultry, with lightning from the south-west; midnight, thermometer 90°, wind a calm, weather very close and sultry.

11th October 1882.—At 6-5 A.M., thermometer 85°, wind light north-west, weather fine but hazy; at 11 A.M., weather fine, wind light north-west; at 3 P.M., weather cloudy and threatening from the north-east, with a good deal of thunder; at 5-55 P.M., thermometer 90°, weather cloudy and threatening from north-east, wind very light north-west; midnight, thermometer 85°, wind light north-west; weather partially cloudy and hazy.

2th October 1882.—At 6-7 A.M., thermometer 82°, wind light north-west, weather fine but hazy; at 11 A.M., weather fine, wind moderate from north-west; at 3 P.M., weather cloudy and threatening from south-east, with thunder, wind moderate north-east; at 4-30 P.M., a heavy shower passed over with a gust of wind, and cleared away in half an hour; at 5-53 P.M., thermometer 84°, wind light north-east, weather partially cloudy; midnight, thermometer 82°, wind light north-west, weather fine with light haze.

13th October 1882.—At 6-7 A.M., thermometer 80°, wind light north, weather cloudy, and threatening rain from south-east; at 8-30 A.M., weather very squally and rainy from the north-east; at 10-30 A.M., weather squally and rainy from the north-east, veering at times to east, and south-east, and then returning to north-east; at 3 P.M., weather cloudy with light rain, wind moderate north-east; at 5-53 P.M., thermometer 80°, wind strong north-east; weather cloudy; midnight, thermometer 80°, wind strong north-east, weather cloudy with rain.

14th October 1882.—At 6-8 A.M., thermometer 74°, wind strong north-east, weather squally and rainy; at 9-15 A.M., weather moderate; at 3 P.M., weather very cloudy with light showers; at 5-52 P.M., thermometer 74°, wind strong north-east, weather very cloudy and rainy; midnight, thermometer 76°, wind strong north-east, weather cloudy and rainy which increased to heavy squalls of wind and rain, varying from north-east, to east, and south-east, and returning to north-east; weather looking very bad to the east, and south-east.

15th October 1882.—At 6-8 A.M., thermometer 72°, wind strong north-east, weather very foul with heavy squalls of wind and rain; at 9-30 A.M., wind veered to south-east and south, weather cleared a little with heavy passing showers at times; at 11 A.M., weather still cloudy with passing showers, wind strong south and south-east; at 3 P.M., weather cloudy with heavy passing showers; at 5-52 P.M., thermometer 80°, wind strong south-east; weather, passing squalls of wind and rain with thunder and lightning; midnight, thermometer 80°, wind strong south-west, weather passing rain squalls.

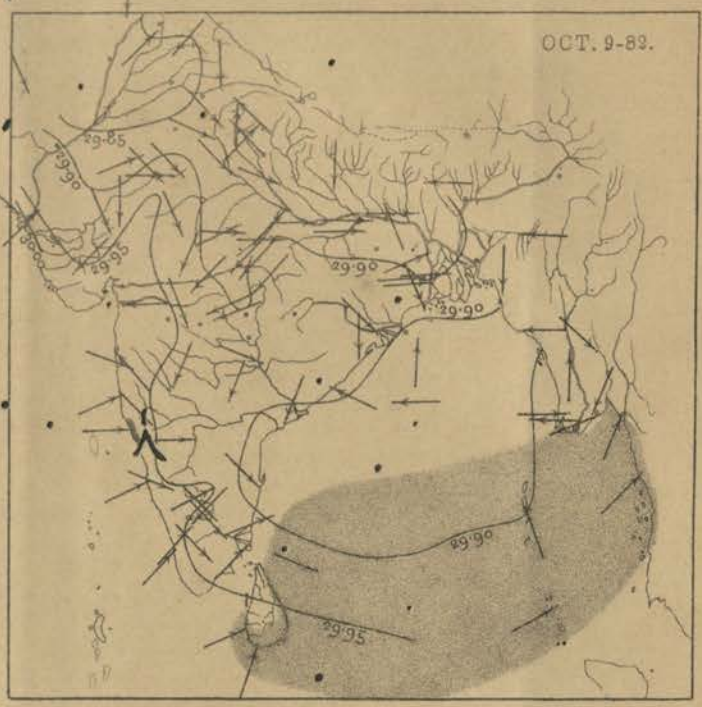
16th October 1882.—At 6-8 A.M., thermometer 80°, wind moderate south-west, weather cloudy and unsettled; at 10-30 A.M., weather partially cleared, but still very dirty-looking to the south-east; wind very strong south-west; at 3 P.M., weather partially clear, wind moderate south-west; at 5-52 P.M., thermometer 81°, wind light south-west, weather cloudy with a good deal of lightning; midnight, thermometer 74°, wind light west, weather cloudy.

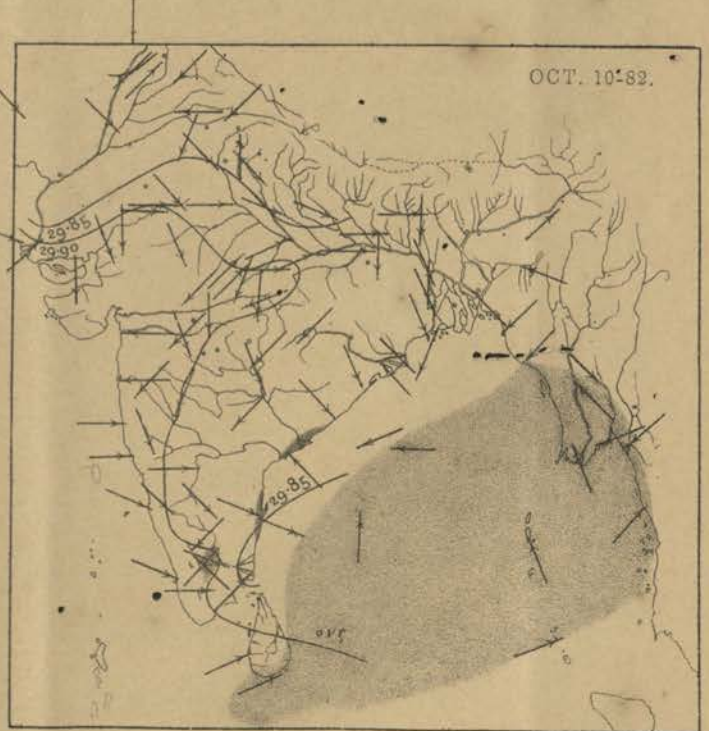
J. H. DANIEL,

Keeper, Cowcolly Light-House.

Government of India Central Printing Office.—No. 2 Meteo.—9-10-84.—400

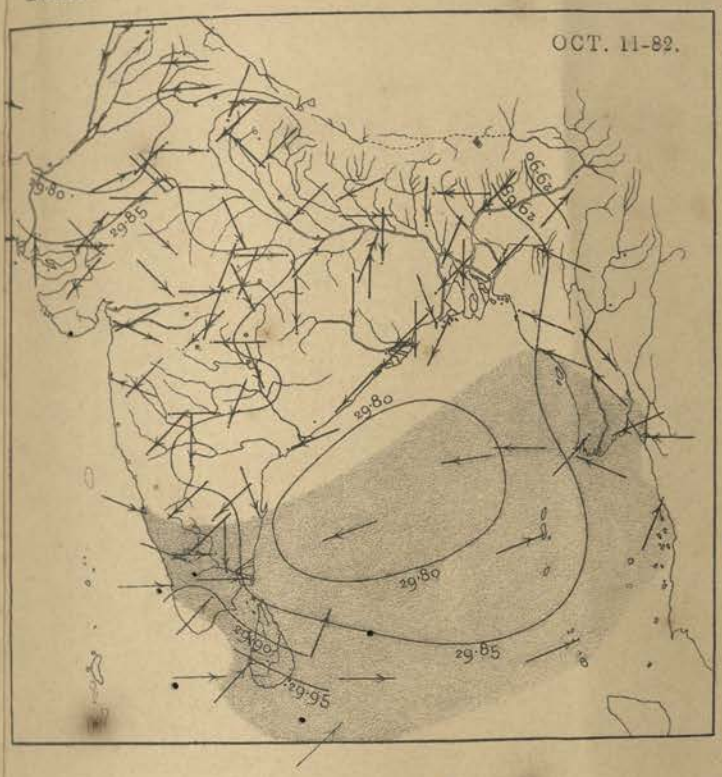
WEATHER CHARTS OF THE 7TH TO 10TH OCTOBER 1882, SHOWING PRESSURE & WIND DIRECTION AT 10 A.M. & RAINFALL.

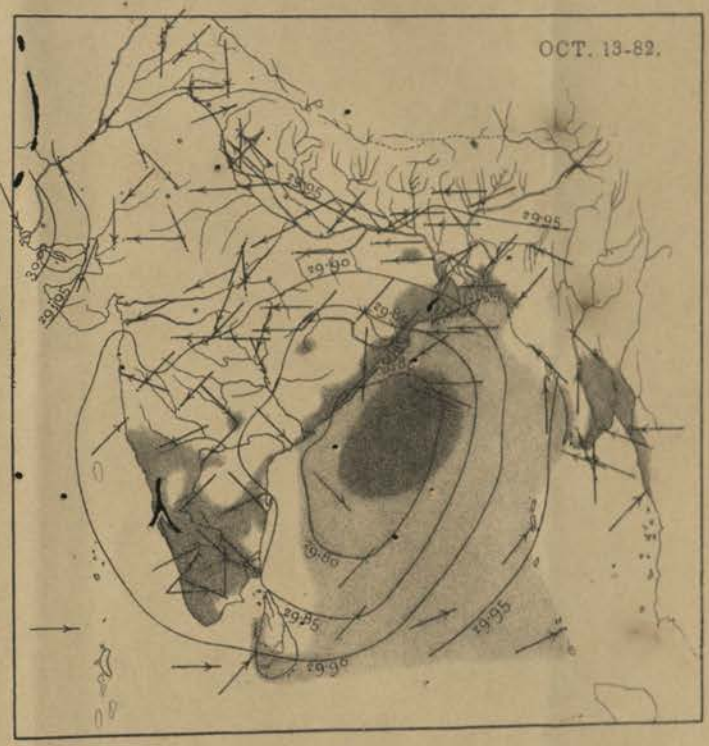


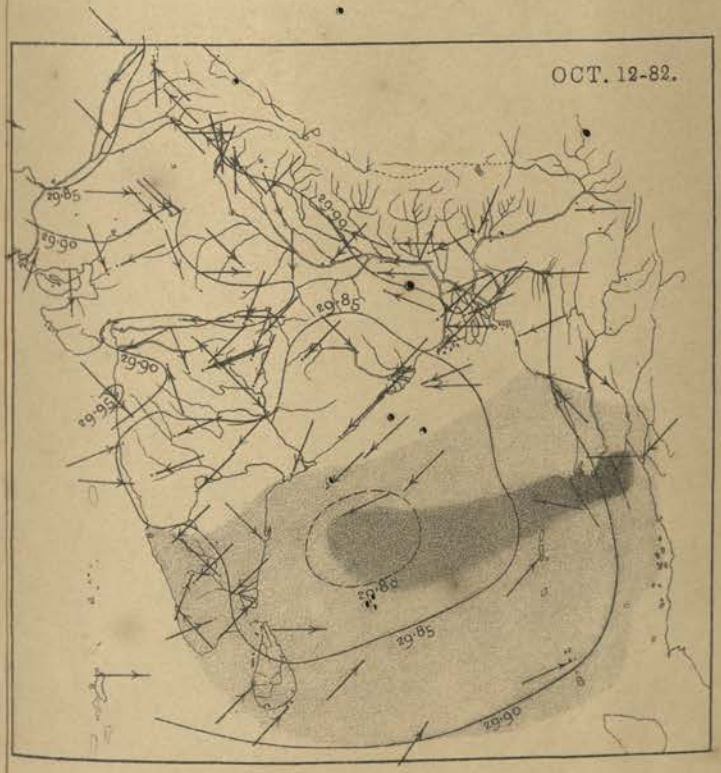


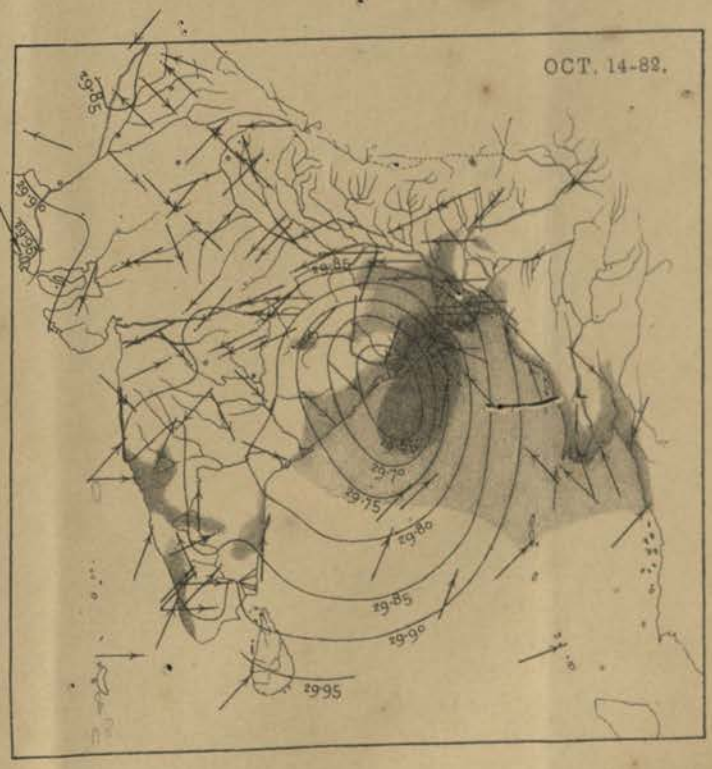
Lithographed at the Survey of India Offices, Calcutta, October 1894.

WEATHER CHARTS OF THE 11TH TO 14TH OCTOBER 1882, SHOWING PRESSURE & WIND DIRECTION AT 10 A.M. & RAINFALL.



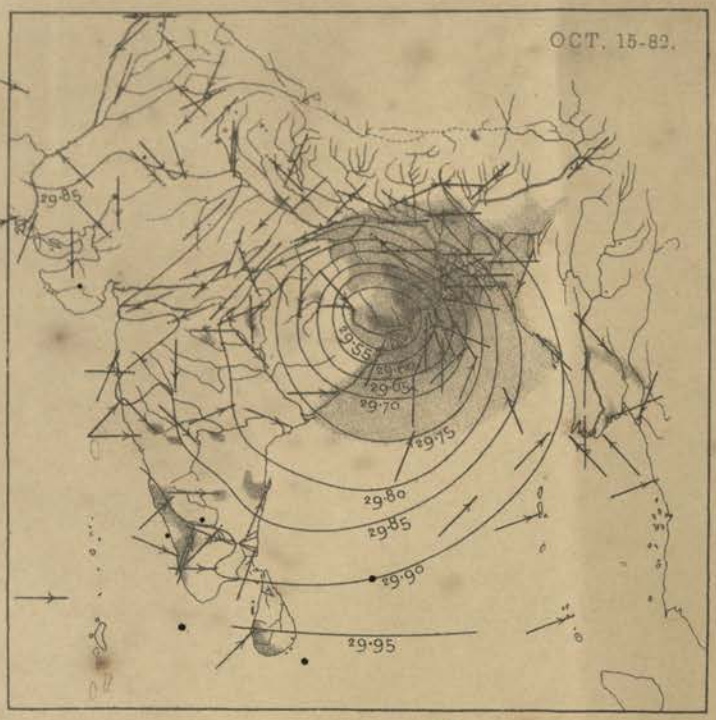


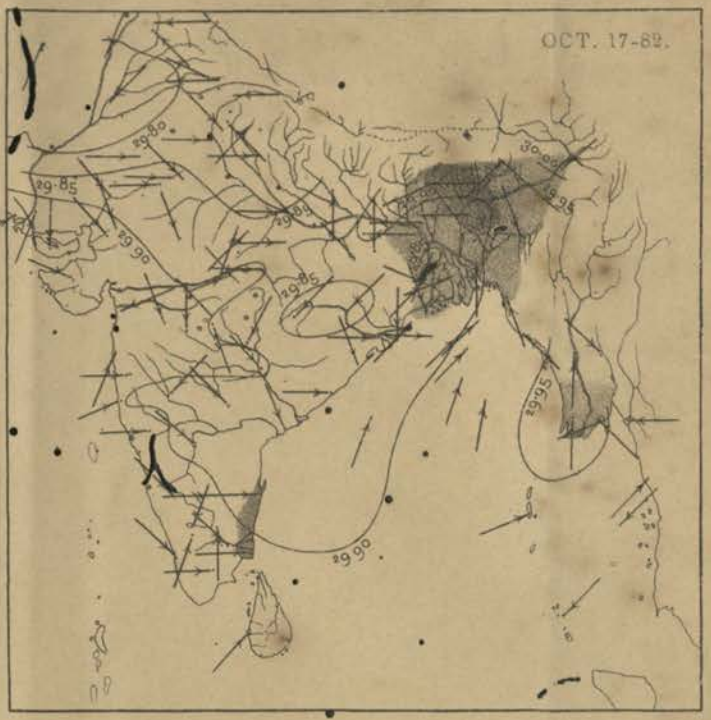


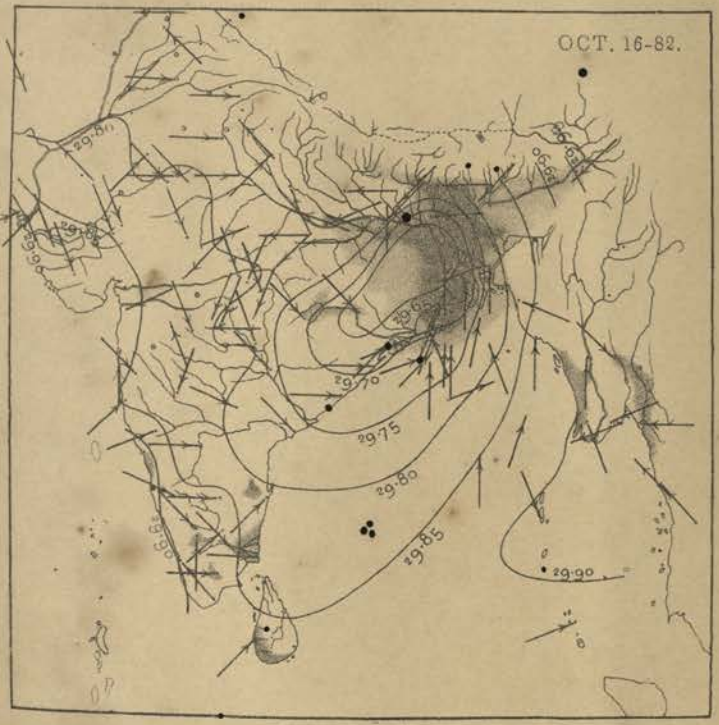


Lithographed at the Survey of India Offices, Calcutta, October 1884.

WEATHER CHARTS OF THE 15TH TO 18TH OCTOBER 1882, SHOWING PRESSURE & WIND DIRECTION AT 10 A.M. & RAINFALL.







Lithographed at the Survey of India Offices, Calcutta, October 1884.

VI.—Account of the South-West Monsoon Storms generated in the Bay of Bengal during the years 1877 to 1881; by JOHN ELIOT, ESQ., M.A., *Meteorological Reporter to the Government of Bengal.*

THE present paper deals with the cyclonic storms of the Bay of Bengal during the south-west monsoons of the years 1877 to 1881. Previous to the year 1882 the Bengal Meteorological Department did not attempt to procure continuous systematic information of the weather in the Bay of Bengal from ships arriving at the port of Calcutta. On the other hand, the India Meteorological Department, in August 1877, arranged for the daily transmission of the 10 A.M. observations taken throughout India by postal reports, and in the year 1878 by weather telegrams, and prepared daily weather charts of the whole of India. These have not been published, but are filed for reference in the India Meteorological Office. They give sufficiently full information for the detection and discussion of all the larger storms which have originated in the Bay and advanced across its shores into the interior of India. The following list of storms has been prepared mainly from these charts, and the discussion has been undertaken as preliminary to the fuller future examination of the generation and phenomena of storms in the Bay of Bengal, which will, it is hoped, result from the labours of the India Marine Meteorological Department:—

No.	Year.	Month.	Day.	DETAILS OF STORM.
1	1877	May . .	12th to 22nd .	This cyclone was generated in the south of the Bay during the period May 12th to 20th. Its centre crossed the coast near the mouth of the Pennaar on the evening of the 18th, shortly after which it was deflected to the north-east, and advanced between the Eastern Ghats and the coast to Cuttack, whence it advanced northwards into West Behár, and North-Eastern Bengal, and was finally broken up near the Himalayas on the 21st and 22nd. (*Vide* Report on the Madras Cyclone of 1877.)
2	„	July . .	11th to 15th .	This storm formed near the head of the Bay on the 10th and 11th, crossed the Balasore coast, and advanced into the Central Provinces, after passing the North Orissa hills. It marched west-north-westwards to the north of Sambalpur and near Jubbulpore, and passed into Central India, where it broke up on the afternoon of the 15th.
3	„	August . .	6th to 10th .	This storm was formed near the head of the Bay, and to the east of the Sandheads on the 5th and 6th. It advanced northwards past Jessore, and was followed by a second vortex formed near the Chittagong coast which moved northwards into the Dacca District on the 9th, where it was broken up early on the morning of the 10th.
4	„	Ditto . .	13th to 17th .	This storm was generated on the 13th, and 14th, at the head of the Bay near the Sandheads. The centre on the 14th was to the south-south-east of Saugor Island, and crossed the coast a little distance to the east of that station on the 15th. It advanced almost due north into North Bengal, and disappeared on the morning of the 17th.
5	„	Ditto . .	18th to 21st .	This storm was formed near the Arakan coast on the 18th. It advanced to the north-north-west and crossed the coast of the Sunderbunds on the evening of the 19th. The centre was between Dacca and Jessore on the 20th, and was then filling up rapidly. It disappeared on the 21st.

No.	Year.	Month.	Day.	Details of Storm.
6	1877	August	27th to 31st	This storm began to form on the 27th in the north of the Bay near the Sandheads. It advanced north-westwards to the Balasore coast, and passed into the Chutia Nagpur district, where it finally broke up on the 31st.
7	„	September	5th to 11th	This storm was generated near the head of the Bay, on the 4th and 5th. It advanced slowly to the west-north-west across the head of the Bay, and the Balasore coast. It then curved slightly to the north, and advanced in a north-north-west direction through Chutia Nagpur into Behar, where it broke up on the 11th.
8	„	November	2nd to 5th	This was a small, irregular, and diffuse storm which was rapidly generated in the centre of the Bay, and passed north-eastwards into Arakan and East Bengal on the 5th, where it broke up during the course of the day.
9	1878	July	20th to 30th	This was formed in the north of the Bay. The centre crossed the Ganjam coast on the 22nd to the north of Vizagapatam, and then advanced north-west to Raipur on the 25th, when it was apparently breaking up. It again intensified, and passed northwards over Sutna on the 27th, and again recurved and marched westwards through Rajputana, passing to the south of Ajmere on the 29th. It disappeared on the 30th in the north-western districts of Rajputana.
10	„	August	1st to 4th	This was developed at the head of the Bay on the 1st and 2nd. It reached the Orissa coast on the 3rd, to the south of False Point, and broke up on the afternoon of the 4th August in the Central Provinces.
11	„	Ditto	6th to 8th	This disturbance was formed on the 6th, probably in the north-west angle of the Bay. It reached the Balasore coast on the morning of the 7th, and advanced westwards into the north-eastern districts of the Central Provinces, where it broke up on the evening of the 8th.
12	„	September	13th to 21st	This storm originated at the head of the Bay on the 13th and 14th, and reached the coast of Orissa near False Point early on the morning of the 15th. It marched in a north-westerly direction across the Central Provinces. The centre was between Jubbulpore and Nagpur on the morning of the 16th, near Khandwa on the 17th, and Surat on the 18th. The depression continued over the lower valley of the Nerbudda and Guzerat on the 18th, 19th, and 20th, and finally disappeared on the 21st in Cutch.
13	„	Ditto	18th to 24th	This storm was formed near the head of the Bay, not far from the Arakan coast, on the 18th and 19th. It probably moved to the north-westward and crossed the coast of the Sunderbunds, 40 or 50 miles to the east of Saugor Island, on the morning of the 21st. It advanced northwards, and was between Calcutta and Jessore on the 22nd, and broke up on the morning of the 24th in Northern Bengal.
14	„	October	13th to 16th	This was a small storm, generated at the commencement of the north-east monsoon on the 13th, near the coast of the Circars. It reached that coast between Masulipatam and Vizagapatam on the afternoon of the 15th, and broke up shortly afterwards.
15	„	Ditto	28th to 31st	This storm began to form in the centre of the Bay on the 27th and 28th. The centre advanced to the north-west, and passed across the coast of the Circars a little to the north of Masulipatam on the 30th. It filled up and disappeared before the morning of the 31st.
16	„	November	3rd to 6th	This storm was generated on the 3rd, in the centre of the Bay, to the west of the Andamans, and advanced in a general north-westerly direction to the coast of the Circars, between Vizagapatam and Masulipatam, which it crossed on the morning of the 5th. It advanced some distance into the interior, where it broke up on the afternoon of the 6th.
17	„	December	4th to 9th	This storm, like the preceding, was generated in the centre of the Bay to the west of the Andamans on the 4th. It marched to the north-west to the coast of the Circars, which it crossed to the north of Masulipatam, and near Vizagapatam on the 8th, and broke up very shortly afterwards.
18	1879	May	19th to 24th	Generated in the south of the Bay, to the south-west of the Andamans, and advanced west-north-west to the Coromandel coast, which it crossed to the north of Madras on the morning of 21st. The cyclonic circulation was partially broken up on the same day, but strong winds were experienced in Mysore until the afternoon of the 22nd.

No.	Year.	Month.	Day.	Details of Storm.
19	1879	May and June	29th to 2nd	This formed near the head of the Bay on the 28th and 29th, crossed the Balasore coast on the morning of the 30th, and advanced into the Central Provinces, to which it gave heavy rain on the 1st. It broke up in the Jubbulpore or Nerbudda Division early on the morning of the 2nd.
20	„	August	8th to 13th	Generated probably in the north-west angle of the Bay on the 7th and 8th, and crossed the Balasore coast early on the morning of the 9th. The centre was to the north-east of, and near, Sambalpur on the morning of the 10th, near Sutna on the morning of the 12th, Jhansi and Gwalior on the 13th, and broke up in Bundelkhand on the evening of the 13th.
21	„	September	12th to 17th	This storm was formed in the north of the Bay to the east of the Sandheads, and probably in the immediate neighbourhood of the Arakan coast on the 12th or 13th. It travelled slowly westward, and crossed the Orissa coast a little to the north of False Point on the afternoon of the 16th. It advanced westward towards Sambalpur, and broke up on the evening of the 17th in the Sambalpur and Raipur Districts of the Central Provinces.
22	„	Ditto	21st to 28th	This storm was apparently generated near the Arakan coast on the 21st and 22nd. It advanced westward and crossed the Orissa coast near Pooree on the morning of the 24th. The centre crossed through the Sambalpur District on the 25th, and the Nagpur Division on the 26th. It passed near Khandwa on the morning of the 27th, and thence advanced over Neemuch on the 28th, after which it broke up and disappeared in South Rajputana.
23	„	October	10th to 15th	A whirl appears to have formed off the Arakan coast on the 10th and 11th, which probably advanced west-north-west towards the Balasore coast, which it crossed on the morning of the 14th. It advanced rapidly through Chutia Nagpur on the 15th into Behar, where it broke up before the morning of the 16th.
24	„	Ditto	25th to 27th	This storm was formed off the Arakan coast in the north-east of the Bay on the 25th and 26th, and probably crossed the coast near Chittagong on the 27th, but rapidly broke up in Eastern Bengal.
25	„	November	1st to 5th	This storm formed in the Gulf of Martaban on the 31st of October and 1st of November near the Tavoy coast. It advanced to the north-north-west, crossing the Rangoon coast on the 2nd, and passed to the east of Rangoon and Henzada. It broke up in the Thyetmyo District on the morning of the 5th.
26	„	Ditto	15th to 20th	This was a small storm. It was generated to the south-west of the Andamans on the 15th, 16th, and 17th, and advanced in a west-north-west direction to the Coromandel coast between Madras and Masulipatam. It crossed the coast on the 19th, and speedily broke up and disappeared before the evening of the 20th.
27	1880	May and June	30th to 4th	This formed at the head of the Bay on the 29th and 30th of May. It advanced on the 2nd across the coast near Saugor Island and marched northwards through the western districts of South-West Bengal into North Behar, where it disappeared on the evening of the 4th.
28	„	June	25th to 30th	This formed at the head of the Bay on the 25th June, and advanced across the Orissa coast near Pooree on the 27th. It marched over the Orissa hills into the Sambalpur District of Chutia Nagpur on the 28th, passed westwards, giving heavy rain to the Central Provinces on the 29th, and filled up on the 30th in the Jubbulpore division of the Central Provinces.
29	„	July	14th to 17th	This storm was generated at the head of the Bay near the Sandheads on the 13th and 14th. It advanced westwards, and crossed the Balasore coast on the afternoon of the 15th, and advanced to the west-north-west into Bundelkhand, where it broke up on the evening of the 17th.
30	„	July & August	31st to 9th	This storm was generated on the 31st July, and the 1st and 2nd of August, near the head of the Bay. The centre was nearly midway between False Point and Saugor Island at 10 A.M. of the 3rd. It advanced in a general west-north-west direction over Sambalpur on the 5th, Jubbulpore and Saugor on the 6th, Indore on the 7th, and broke up finally and disappeared on the 9th in North Rajputana near the southern borders of the Punjab.

No.	Year.	Month.	Day.	Details of Storm.
31	1880	August .	18th to 25th .	Generated in the north of the Bay on the 18th, 19th, and 20th. The centre was midway between False Point and Saugor Island on the morning of the 21st. It crossed the coast on the same day and moved steadily towards Chyebassa, near which place it was on the 23rd. It then curved slightly to the east, and advanced towards Purneah, near which place it broke up on the evening of the 25th.
32	„	September ...	12th to 19th .	Apparently generated in latitude 19° on the 12th and 13th, and crossed the coast of Ganjam near Gopalpur on the 14th. The centre was a short distance east of Raipur on the morning of the 15th. It advanced to the neighbourhood of Nagpur on the 16th, Indore on the 17th, and to Agra on the 18th, and finally disappeared on the 19th in Rohilkhand, to which and the neighbouring divisions of the North-West Provinces it gave excessively heavy rain.
33	„	Ditto .	21st to 26th .	This was formed near the head of the Bay on the 21st and 22nd, and consisted of two whirls. The second crossed the Balasore coast on the 23rd, and advanced nearly due west past Sambalpur on the 24th, and Raipur on the 25th, and broke up on the evening of that day in the Central Provinces.
34	„	October .	12th to 15th .	This was apparently formed immediately before the setting-in of the north-east monsoon on the Coromandel coast. The coast observations indicated its existence in the centre of the Bay on the 12th. It advanced westwards, and struck the coast near Vizagapatam early on the morning of the 14th. It moved north-westwards into the Central Provinces on the 15th, where it filled up and disappeared.
35	„	November .	19th to 22nd .	Formed in the south of the Bay, advanced across the Negapatam coast on the 21st, and broke up on the 22nd. The depression exceeded half an inch, and the disturbance gave heavy local rain in Southern India.
36	1881	May . .	26th to 28th .	This storm was generated at the head of the Bay on the 25th and 26th. The centre crossed the coast of the Sunderbunds on the afternoon of the 26th, and advanced northwards, past Jessore, into North Bengal, where it broke up on the 28th.
37	„	June . .	1st to 5th .	This formed, like the preceding, at the head of the Bay, more slowly, on the 2nd, 3rd, and 4th, and advanced across the Sunderbunds coast into the Jessore District on the 5th, where it broke up in the course of the day.
38	„	Ditto . .	6th to 9th .	This storm formed in the rear of the preceding on the 5th, in the north-west angle of the Bay. The centre advanced across the Orissa hills, and was near Raipur on the 7th, Seoni on the 8th, and gave heavy rain over the Central Provinces on the 8th and 9th, and filled up on the 10th.
39	„	Ditto . .	13th to 19th .	This was formed under similar circumstances to the preceding, near the head of the Bay on the 13th and 14th. It advanced across the Balasore coast early on the morning of the 15th, and moved northwards along the edge of the Chutia Nagpur plateau, and hills of the Sonthal Pergunnahs into North Behar, where it broke up on the 18th and 19th.
40	„	July . .	2nd to 4th .	This storm was generated on the 2nd, in the north-west angle of the Bay. The centre advanced across the Balasore coast and the North Orissa hills into the Central Provinces, where it broke up near Nagpur on the evening of the 4th.
41	„	Ditto . .	12th to 18th .	This storm formed at the head of the Bay to the east of the Sandheads, on the 12th and 13th, moved very slowly westwards, and advanced across the Bengal coast near the mouth of the Hooghly on the morning of the 16th. It advanced rapidly westwards to Jubbulpore on the 17th, and into Bundelkhand on the 18th, where it filled up.
42	„	August . .	1st to 4th .	This storm formed in the north-west of the Bay on the 1st and 2nd. It advanced across the Orissa coast, near False Point, on the afternoon of the 2nd, and passed rapidly through the Central Provinces, Central India, and the northern districts of the Bombay Presidency, and filled up on the evening of the 4th near the coast of Sind.
43	„	Ditto . .	16th to 19th .	This storm formed under similar circumstances to the preceding on the 16th and 17th. It advanced across the Balasore coast on the evening of the 18th, and passed to the west-north-west into Chutia Nagpur, and filled up on the evening of the 19th.

No.	Year.	Month.	Day.	Details of Storm.
44	1881	September .	10th to 14th .	This storm was generated near the head of the Bay on the 10th and 11th. The centre marched across the Orissa coast near False Point early on the morning of the 12th, and passed rapidly westwards, and was near Hoshangabad on the 13th, Neemuch on the 14th, and filled up on the evening of the 14th in South-West Rajputana.
45	„	October .	2nd to 9th .	This was a storm which was generated at the commencement of the north-east monsoon, in the centre of the Bay. It advanced north-westwards towards the coast of the Circars, which it crossed to the north of Vizagapatam on the 5th. It gave irregular cyclonic circulation in the Central Provinces on the 6th, and passed northwards through Chutia Nagpur into Behar, to which it gave heavy rain on the 7th and 8th. It disappeared in Central Behar on the afternoon of the 9th.
46	„	November .	10th to 13th .	This storm formed in the south-west of the Bay, and advanced in a north-westerly direction to the Madras coast, which it crossed near Madras on the morning of the 13th. It disappared before 10 A.M. of the 14th.

1877.

One object of this paper is to indicate that there are probably definite relations between the number, character, and paths of the south-west monsoon storms of the Bay of Bengal, and the larger abnormal meteorological conditions of the year. It is, therefore, necessary to state briefly the abnormal features of each year. These are described at length in the Annual Reports on the Meteorology of India, compiled by the Meteorological Reporter to the Government of India. The meteorology of the year 1877 was very unusual. During a period of nearly two years, extending from May 1876 to August 1878, the whole of the Indian area was characterized by continuous excessive pressure. The months of August and September 1877 also witnessed the termination of the great Madras Famine. The cold weather of 1876-77 was remarkable for excessive snowfall over the Himalayas. During the first five months of the year, temperature was considerably below the average in Northern India, whilst it was above it to a less extent in Southern India and the Deccan. These conditions were reversed in the month of June, and during the south-west monsoon months, temperature was excessive in Northern India, whilst it was, on the whole, below the average in Southern India, more especially during the months of August and September. Pressure, as has been already remarked, was steadily above the normal during the whole year. The most remarkable feature of the year was a belt, or ridge, of excessive pressure, which stretched across the head of the Peninsula. The observations at the stations of Bombay, Kurrachee, Ajmere, Jhansi, Jubbulpore, Khandwa, and Cuttack fully establish the continued existence of this belt during the whole year. It was most prominent before and during the south-west monsoon period, and practically demarcated the area which received abundant or excessive rainfall during the monsoon from that in which it was deficient. There were also a few local peculiarities of pressure, but not of sufficient importance to be mentioned.

The air motion over Northern India during the south-west monsoon was remarkable. Before that season, winds were approximately normal in character, and in the majority of cases, slightly feebler than the average.

Dry hot westerly winds continued, with few exceptions, over the whole of the North-West Provinces, and a large portion of Behar, and Chutia Nagpur, during the rains, and thus gave an unusually strong westerly element to the monsoon winds at the head of the Bay, which were thrust mainly into Burmah, Aracan, and East Bengal. Hence the Bombay monsoon current chiefly prevailed to the south of the Satpuras in the Deccan, whilst the Bay of Bengal monsoon current advanced into Burmah, Aracan, and East Bengal, and was deflected up the Gangetic plain to a considerably less extent than usual. It only penetrated beyond Behar at distant intervals. The distribution of the rainfall was in accordance with the meteorological conditions described above. The Bombay monsoon current gave abnormally heavy rain to the west coast of India as far north as Ratnagiri, but did not penetrate to any extent beyond the Western Ghats into Mysore, the Deccan, &c., until the month of August, when copious rain commenced to fall, and terminated the Madras Famine of 1876-77. The rainfall of the whole monsoon period was very deficient over the northern districts of Bombay, Rajputana, Central India, the North-Western Provinces, Oudh, Behar, and the greater part of the Punjab. For example, the average amount received in the North-West Provinces between the 15th of June and 15th of September was slightly less than 9 inches, whilst the normal fall of the same period is 24 inches. On the other hand, Burmah, Aracan, Bengal, and Orissa obtained excessive or normal rainfall. The south-west monsoon rains terminated in Bengal about the 15th of October. The monsoon humid current recurved immediately, and set in on the Coromandel Coast in the third week of October as the north-east monsoon. It gave unusually abundant rain over Southern India during the last fortnight of October, and the month of November.

(*No. I.*)—*Storm of May 14th to the 23rd.*—This was a storm which formed at the commencement of the south-west monsoon in the south of the Bay, and, after advancing to the Madras coast, recurved, and moved along, and in a direction parallel to, the coast into Behar, where it finally broke up. It is fully described in the "Report on the Madras Cyclone of 1877," from which the following very brief summary of its history is taken.

Pressure was unusually high over the whole of India in April and the beginning of May, and the excess was greatest in Northern India. The centre of the Bay formed the area of highest pressure in the Indian area during the first twelve days of May. Rainfall commenced near the equator and advanced northwards, so that the south-west monsoon was approaching the south of India and the entrance to the Bay at this period. A depression began to form on the 14th to the north-east of Ceylon, which intensified rapidly during the next two days, and drifted in a north-westerly direction to the Madras coast. It crossed the Coromandel coast to the north of Madras, and near the mouth of the Pennaar, on the afternoon of the 18th, and shortly after recurved, and moved in a general north-easterly direction. Very heavy rain fell over the whole of the coast area from Madras northwards. The positions of the centre on the 19th and 20th are somewhat doubtful, and the cyclonic circulation was less regular than hitherto. The vortex was in West Bengal on the morning of the 21st, to the north-west of Berhampore, near Rajmehal. The cyclonic circulation continued on the 22nd about a centre in North Behar, which moved very slowly northwards. It commenced to break up rapidly on the 23rd, on the evening

of which day it disappeared. The following table gives approximately the position of the centre at 10 A.M. of each day during its existence:—

	Position of centre.		Distance passed over by centre during previous 24 hours.	Rate of motion in miles per hour.
	Latitude.	Longitude.		
May 15, 10 A.M.	10° 0′ N	83° 0′ E	...	...
„ 16 „	11° 0′ N	82° 0′ E	100	4
„ 17 „	12° 20′ N	81° 30′ E	100	4
„ 18 „	14° 30′ N	80° 45′ E	160	7
„ 19 „	17° 0′ N	81° 30′ E	170	7
„ 20 „	20° 0′ N	85° 0′ E	320	13
„ 21 „	23° 30′ N	87° 30′ E	275	12
„ 22 „	25° 20′ N	87° 30′ E	140	6

The following were the characteristic and more remarkable features of the cyclone:—

1st.—It was formed in the front of the first rush of the south-west monsoon winds into the Bay.

2nd.—The humid winds which accompanied it were unusually strong, and charged with vast quantities of moisture, which gave excessive rainfall over the whole line of its path from the Madras coast to North Behar and Bengal. The following table gives the average daily rainfall in each of the divisions of Bengal during its passage through that Province:—

Division.	May 17th.	May 18th.	May 19th.	May 20th.	May 21st.	Total.
Burdwan	0·24	0·45	0·65	0·10	0·18	1·62
Presidency	0·18	0·61	0·55	0·13	0·23	1·70
Rajshahye	0·06	0·39	0·34	2·13	3·02	5·94
Cooch Behar	0·15	0·70	0·50	1·30	5·54	8·19
Dacca	0·37	0·61	1·10	0·51	0·46	3·05
Chittagong	0·12	0·87	2·08	0·39	0·51	3·97
Patna	...	0·01	0·08	1·55	1·28	2·92
Bhagulpore	...	0·02	0·41	1·84	2·19	4·46
Orissa	0·69	0·75	0·74	0·27	0·05	2·50
Chutia Nagpur	0·02	0·54	0·54	0·55	0·79	2·44

3rd.—The rainfall was heaviest in the narrow strip of country over which the storm proper passed. The following return, giving the actual rainfall at several of the stations

near the centre during its motion, will illustrate more fully than the preceding the character of the aqueous vapour condensation which accompanied the storm :—

Station.	May 19th.	May 20th.	May 21st.	Total.
Rungpore	0·45	4·12	11·16	15·73
Bogdogra	...	3·10	12·19	15·29
Cooch Behar	...	2·14	9·77	11·91
Boda	1·68	...	8·52	10·20
Gya	0·72	5·06	4·62	10·40
Nawada	...	8·00	2·03	10·03
Aurungabad	...	8·68	...	8·68
Bhagulpore	2·35	3·13	3·40	8·88
Rajmehal	...	5·20	4·00	9·20

4th.—Another remarkable feature of the cyclone is that, although it was an unusually powerful one, initiated slowly under favourable conditions, it was not able to surmount the comparatively low elevations of the Eastern Ghats and Orissa Hills. It was deflected almost immediately after it crossed the west coast of the Bay, and apparently rolled along the edge of the high land until it reached the Ganges near Rajmehal, where it passed into North Behar and Bengal. It was a cyclone of the May transition period, and of low elevation; and the supplies of vapour which were poured into it in the eastern quadrant (the active quadrant) maintained its motion for several days, notwithstanding the large resistances of the hills in its western quadrant.

(*No. II.*)—*Storm of July 11th to the 15th.*—This is an example of a class of storms of occasional occurrence during the period when both branches of the monsoon current are fully established. They originate near the head of the Bay, and move westwards across the Orissa Hills, where they acquire increased vitality from the influence and action of the Bombay current, and march across the head of the peninsula, giving heavy rain and severe floods to the area over which they pass. Its existence was first indicated by the observations of the 11th at the Bengal coast stations.

11th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Akyab	29·677	—·052	S	4	110	1·75
Chittagong	·576	—·110	E	5	70	*Nil.*
Saugor Island	·574	—·022	NNW	15	113	0·10
False Point	·617	—·009	W	?	?	5·40
Cuttack	·623	+·002	W	5	147	1·92
Vizagapatam	·678	+·012	NW	1	23	*Nil.*

The observations show that a cyclonic circulation was established at the head of the Bay. Moderately heavy rain was falling in Aracan, due to the Bengal branch of the

monsoon current, and very heavy rain in Orissa, to which the Bombay branch at that time extended. The winds were of moderate strength, and were about 50 per cent. stronger than the normal in Orissa. The following table gives the average rainfall of the 11th :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
East Bengal	22	0·34	1·42
South-West Bengal	47	0·36	1·76
Orissa	13	2·40	5·50

Kendrapara in the Cuttack district received 5·5 inches, and False Point 5·4 inches.

12th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction, 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Akyab	29·717	—·012	S	6	167	3·90
Chittagong	·635	—·051	E	12	167	0·10
Saugor Island	·392	—·204	NNW	14	105	8·01
False Point	·545	—·081	W	?	?	0·75
Cuttack	·549	—·072	W	5	147	1·42
Vizagapatam	·664	—·002	WNW	0·5	21	0·10

These observations show that the cyclonic circulation was slowly intensifying. The barometer had fallen rapidly at Saugor Island, and the winds had strengthened considerably in the eastern quadrant, represented by Akyab and Chittagong. The wind directions were unchanged, and indicate that the centre was to the south of the coast of the Sunderbunds, and probably marching almost due west. The rainfall in Bengal and Orissa during the previous 24 hours is given below —

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·46	1·20
South-West Bengal	47	0·73	8·30
Orissa	13	2·65	12·04
Central Provinces	75	0·59	4·42

The following stations received falls exceeding 5 inches: Saugor Island 8·3 inches, Balasore 12·04 inches, and Bhuddruk (in the Balasore district) 6·0 inches.

13th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours	Ratio of amount of wind to average amount expressed as a percentage.	
Saugor Island	29·543	—·053	SSW	21	158	...
False Point	·525	—·101	SW	?	?	0·70
Cuttack	·466	—·155	SSW	8	235	1·73
Sambalpur	·393	—·228	W	3	100	4·60
Raipur	·496	—·119	NW	15	132	0·83
Nagpur	·638	—·015	NW	6	85	0·85
Vizagapatam	·587	—·079	WNW	3	70	...

The disturbance had been transferred to the Central Provinces during the previous 24 hours. The centre crossed the North Orissa coast between Balasore and False Point, and marched intact in a westerly direction over the North Orissa Hills, and was at 10 A.M. near to Sambalpur, and a little to the north of it. The depression at the centre of a storm crossing the Hills of Orissa usually decreases during its passage. In the present example, the depression was probably ·4″ when advancing to the south of Saugor Island, and was not greater than ·25″ when near Sambalpur.

The average rainfall of Bengal, Orissa, and the Central Provinces is given in the following table:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·52	1·55
South-West Bengal	47	0·72	4·02
Orissa	13	1·82	5·00
Central Provinces	75	1·00	4·60

The rainfall was heaviest in Orissa, but was now decreasing in amount, whilst it was increasing considerably in the Central Provinces.

14th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Sambalpur	29·588	—·028	SW	13	433	1·65
Raipur	·536	—·079	SW	7	61	1·80
Jubbulpore	·454	—·169	N	5	96	2·09
Nagpur	·596	—·057	W	12	169	0·88
Khandwa	·671	+·016	W	7	80	1·15
Sutna	·522	—·052	NE	2	21	0·39
Allahabad	·552	—·010	E	8	216	0·41
Hazaribagh	609	+·026	ESE	21	244	0·05

The centre was near Jubbulpore on the morning of the 14th, so that it had continued to advance almost due west. The depression at the centre was less and the air motion somewhat irregular. It was considerably below the average at several stations (more especially at Jubbulpore, which was nearest the centre), and above it at others chiefly in the south quadrant. Heavy rain was falling at this time over the whole of the Central Provinces, due to the indraught of the moist current from the Bombay coast. The rainfall in Orissa was diminishing very rapidly in amount, as is shown by the following :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·53	1·42
South-West Bengal	47	0 52	1·72
Orissa	13	0 35	2·00
Central Provinces	75	1·66	7·20

The following gives the rainfalls exceeding 5 inches, all of which occurred in the Central Provinces :—

Station.	District.	Rainfall.
Shahpur	Betul	7·20
Chicoli	Betul	6·32
Narsinghpur	Narsinghpur	7·06
Mortakha	Nimar	6·00
Seori Narain	Bilaspur	5·14

15th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Sambalpur	29·690	+·074	SW	1	33	...
Raipur	·676	+·061	SW	14	123	0·02
Jubbulpore	·605	—·018	SE	7	135	0·15
Nagpur	·686	+·033	SW	15	211	0·59
Khandwa	·625	—·030	SW	16	184	4·95
Saugor	?	?	NE	4	87	0·53
Ajmere	·555	—·025	N	3	43	0·71
Deesa	·683	+·064	SSW	?	?	0·07
Indore	·677	+·011	W	?	?	...

The preceding observations indicate that the centre of the disturbance had continued its westward motion during the previous 24 hours, and was near Indore, or midway between Khandwa and Deesa at 10 A.M., and that it was now filling up rapidly. Strong south-westerly winds were blowing to the south of the centre. The diminution in the strength of the winds after the passage of the vortex is strikingly shown by the Sambalpur returns. Heavy rain fell over the northern and western districts of the Central Provinces, but the average for the province was less than on the 14th. The general distribution of rainfall is indicated by the following averages :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·34	1·53
South-West Behgal	47	0·03	0·38
Orissa	13	*Nil*	.....
Central Provinces	75	1·09	9·32

Rainfalls exceeding 5 inches were registered at the following stations :—

Station.	District.	Rainfall.
Hoshangabad	Hoshangabad	9·32
Sohagpur		7·00
Hardui		6·91
Seoni		5·76
Badaun	Betul	5·47
Gudawara	Narsinghpur	5·25

The depression filled up rapidly during the afternoon and evening of the 15th, and the observations of the morning of the 16th show no traces of its existence.

(*No. III.*)—*Storm of August 6th to the 10th.*—This and the succeeding small storm are examples of two cyclonic vortices being formed at the head of the Bay within short intervals of each other; the second one usually generated further to the east than the earlier, and before the latter had broken up.

The land observations first indicated the existence of the earlier storm on the morning of the 6th August—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·616	—·153	SSW	4	125
Chittagong	·562	—·177	E	6	100
Dacca	·566	—·128	SE	5	80
Calcutta	·543	—·121	NE	4	77
Saugor Island	·511	—·148	NNW	11	98
False Point	·593	—·090	W	P	P
Cuttack	·567	—.111	WSW	4	132
Vizagapatam	·657	—·057	WNW	2	47

The centre was to the south-east of Saugor Island, and nearly due south of Jessore. The depression at Saugor Island was ·15″, and at the centre was probably between ·2″ and ·3″. The winds were, as is generally the case at the commencement of the small storms at the head of the Bay, lighter than the normal at all stations, except at Akyab, and on the West Pegu coast, where moderately strong southerly monsoon winds were blowing. The rainfall in Bengal was very small in amount, and the weather was generally fine, with light variable winds. The following averages indicate the character of the rainfall at this time :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·21	0·89
South-West Bengal	47	0·09	0·70

7th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·541	—·228	SW	8	250
Chittagong	·483	—·256	ESE	6	99
Dacca	·473	—·221	SE	3	48
Jessore	·446	—·241	N	3	73
Saugor Island	·517	—·142	WSW	9	89
Cuttack	·586	—·092	W	3	90
False Point	·591	—·092	W	?	?
Vizagapatam	·655	—·059	WNW	1	35

These observations establish that the vortex had crossed the coast, and was in the immediate neighbourhood of Jessore, and to the east of it. The disturbance covered a large area and the depression varied in amount between ·14″ and ·3″ over the whole of South Bengal, Aracan, and the head of the Bay, and probably very slightly exceeded ·3″ at the centre. The air motion of the previous 24 hours was below the average at all stations except Akyab. The rainfall, although larger than on the 6th, was small in amount, as is shown by the following table :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall in preceding 24 hours.
East Bengal	22	0·31	2·24
South-West Bengal	47	0·27	2·60

8th August.

Station.	Barometer at 10 A.M. reduced to sea-sevel.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·592	—·177	SSW	8	250
Chittagong	·405	—·334	WSW	4	59
Dacca	·456	—·238	E	4	64
Jessore	·477	—·210	WNW	4	98
Saugor Island	·514	—·145	WSW	16	150
Cuttack	·579	—·099	W	4	142
False Point	·580	—·103	W	?	?
Vizagapatam	·661	—·053	NW	4	120

A reference to the observations of the 6th and 7th shows that a local fall had occurred on the evening of the 6th on the Aracan and Chittagong coasts, which formed part of, and was due to, the same general disturbance as the preceding, but was almost certainly not produced by the continuation of the motion of the existing vortex. A further fall had taken place during the previous 24 hours, and the barometer at Chittagong was ·33″ below the average. The wind directions also show that there was cyclonic motion about a centre between Chittagong and Dacca, and probably near to Chittagong. Hence it is almost certain this was due to the passage of a second vortex, which had formed in the rear of the first, and crossed the coast further to the east than the former. The air motion in the immediate neighbourhood of the centre was less than the average. Strong south-west to west winds were blowing at Akyab, and also in South-West Bengal and Orissa. Heavy rain was falling in East and South-West Bengal, as is shown by the following :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest fall during the previous 24 hours.
East Bengal	22	1·59	9·49
South-West Bengal	47	1·42	6·85

Rainfalls exceeding 5 inches were recorded at the following stations in Bengal :—

	District.	Station.	Rainfall.
East Bengal	Chittagong	Cox's Bazar	9·49
South-West Bengal	Jessore	Maroora	6·85
Ditto	Nuddea	Bongong	5·57

9th August.

Station.	Barometer at 10 A.M. reduced to sea level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·605	—·16	SW	7	220
Chittagong	·464	—·275	ESE	18	285
Dacca	·356	—·338	N	3	145
Jessore	·437	—·250	NW	7	170
Calcutta	·493	—·171	WNW	9	175
Saugor Island	·503	—·156	W	17	155
False Point	·601	— 082	W	?	?

The second cyclonic vortex had advanced northward during the preceding 24 hours, and was at 10 A.M. in the immediate neighbourhood, and to the east, of Dacca, where the barometric depression was ·34″. The first vortex had completely disappeared or merged into the second during the previous 24 hours. Strong winds were now blowing over the whole of South Bengal, more especially to the south-east of the centre. The average wind velocity of the preceding 24 hours at Chittagong was nearly three times its normal amount. The following table shows that heavy rain fell over the whole of East and South-West Bengal :—

	Number of stations.	Average fall of previous 24 hours.	Heaviest fall of previous 24 hours.
East Bengal	22	2·44	10·25
South-West Bengal	47	1·25	4·70

Rainfalls of 5 inches or upwards were registered in the following cases :—

	District.	Station.	Rain.
East Bengal	Chittagong	Chittagong	10·25
Ditto	Chittagong Hill Tracts	Rangamatee	5·43
Ditto	Noakholly	Fanny	5·00

The cyclonic vortices which advance into Eastern Bengal are nearly always short-lived, as they are speedily disintegrated by the action of the Tipperah Hills, which cut radially across the eastern or active half of the storm area, and the present was an example.

The following observations show that there was no cyclonic motion on the morning of the 10th, and that the barometric depression was rapidly filling up:—

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as percentage.
Chittagong	29·628	—·111	SE	7	111
Dacca	·596	—·098	SE	13	210
Jessore	·575	—·112	SSE	7	171
Calcutta	·550	—·114	SE	11	216
Silchar	·638	—·098	ENE	3	94

The rainfall of the preceding 24 hours in East Bengal was small in amount as compared with that of the previous two days—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall previous 24 hours.
East Bengal	22	0·37	1·59
South-West Bengal	47	1·81	5·92

(*No. IV.*)—*Storm of August 13th to the 17th.*—This was a small storm which commenced to form on the 13th August. The barometer fell rapidly on the 12th and 13th, and the wind directions at the coast stations on the morning of the 14th indicated the establishment of a small cyclonic vortex at the head of the Bay. The following are the observations for that day at the nearest land stations:—

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Calcutta	29·541	—·123	NE	7	135
Cuttack	·583	—·095	W	3	100
Saugor Island	·491	—·168	N	8	75
Jessore	·545	—·142	ESE	4	100
Dacca	·611	—·083	SE	6	100
Chittagong	·655	—·084	SSE	6	100

These observations show that the centre was not far from Saugor Island, and to the south-south-east, probably at a distance not exceeding 60 or 80 miles, and near the Sandheads. The depression at Saugor Island was ·17″ and at the centre was probably between ·2″ and ·3″.

The winds were either of normal strength, or below it, as at Saugor Island, where the winds were northerly.

The rainfall in Bengal and Orissa was not large in amount. Its distribution is given by the following table:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·42	1·70
South-West Bengal	47	0·35	1·20
Orissa	13	0·88	2·15

15th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Chittagong	29·616	—·123	S	11	170
Saugor Island	·495	—·164	SW	17	158
Cuttack	·626	—·052	SSW	5	165
Calcutta	·456	—·208	NW	12	240
Burdwan	·487	—·181	N	7	167
Jessore	·458	—·229	SSE	8	188

The centre had advanced to the NNW, and crossed the coast near to Saugor Island, probably to the east of it, as indicated by the 4 P.M. observations of the 14th, and was to the north of Saugor Island, and between that station and Calcutta and Jessore, at 10 A.M. It was probably nearest to Calcutta. The winds were considerably above the average at the stations nearest to the centre.

The rainfall was larger in amount in South-West Bengal, but was not excessive. The greatest amount registered at 6 P.M. for the previous 24 hours was 4·37 inches.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·37	1·33
South-West Bengal	47	0·78	4·37
Orissa	13	0·73	1·59

16th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jessore	29·485	—·202	W	6	134
Berhampore	·469	—·211	W	6	150
Purneah	·486	—·172	NE	2	70
Patna	·482	—·172	WNW	1	50
Hazaribagh	·512	—·142	W	9	120
Burdwan	·494	—·174	WSW	6	140

The position of the centre, as indicated by these observations, was in the Maldah District near the great bend of the Ganges at Rajmehal. The observations show that the central depression was less than on the 15th. The air motion in the southern quadrant was slightly in excess of the normal, but was below it at stations to the north and west. The vortex was evidently breaking up. Heavier rain fell during the previous 24 hours than on the 14th and 15th in Bengal. East and South-West Bengal received an average of one inch. The following gives the average provincial data :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Bengal	22	0·72	3·36
East Bengal	22	1·00	5·38
South-West Bengal	47	1·01	4·86
Orissa	13	0·20	0·70

Mymensingh in East Bengal received 5·38 inches, which was the only fall exceeding 5 inches.

The observations of the 17th show that the cyclonic vortex had completely disappeared, and that monsoon winds, stronger than the average, were established in Bengal and Orissa. The rainfall was small in amount except in East Bengal. These facts are shown by the following tables :—

17th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·668	—·101	SW	7	200
Chittagong	·575	—·164	Calm	9	145
Jessore	·538	—·149	SW	5	110
Saugor Island	·573	—·086	SW	24	225
Cuttack	·626	—·052	SW	5	145

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Bengal	22	0·92	3·20
South-West Bengal	47	0·10	2·68
East Bengal	22	3·15	9·52

(*No. V.*)—*Storm of August 18th to the 21st.*—The chart of the 18th shows that another small cyclonic vortex was forming near the Aracan coast, which, like the preceding,

advanced into Bengal, and after a short existence on land broke up in Central or North Bengal. The following gives the observations of the 18th taken at the stations near the head of the Bay:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·726	—·043	SW	4	140
Chittagong	·673	—·066	ENE	8	135
Saugor Island	·635	—·024	SSW	18	165
Cuttack	·679	+·001	SW	6	203
Vizagapatam	·732	+·018	W	2	70

The barometer was lowest at Saugor Island, where the south-westerly winds, which followed the advance inland of the preceding storm, were still blowing with considerable force. The north-easterly winds, which had set in during the previous 24 hours at Chittagong, and south-westerly winds at Akyab, were the first signs of indraught to another cyclonic vortex. Strong south-westerly winds continued in South-West Bengal and Orissa, uninfluenced as yet by the formation of the cyclonic vortex near the Aracan coast. Heavy rain fell in Bengal during the day, as is shown by the following rainfall averages:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	2·37	5·48
South-West Bengal	47	1·13	6·12
North Bengal	22	1·29	8·38

19th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·734	—·035	SSW	4	120
Chittagong	·669	—·070	Calm	9	135
Saugor Island	·671	+·012	WSW	14	125
Cuttack	·682	+·004	SSW	5	165
Vizagapatam	·733	+·019	NW	1	41

The meteorological conditions were generally similar to those of the previous day. The cyclonic disturbance is less plainly indicated, but the south-westerly winds in Orissa

and South-West Bengal were diminishing in strength. They, however, continued to give heavy rain to Bengal.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	2·67	7·13
South-West Bengal	47	1·15	5·20
North Bengal	22	1·10	5·60

20th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·747	—·022	S	3	100
Chittagong	·629	—·110	S	7	115
Jessore	·629	—·058	W	8	200
Dacca	·620	—·074	SW	11	175
Saugor Island	·679	+·020	NNE	14	125
Calcutta	·667	+·003	NW	5	105
Cuttack	·682	+·004	W	4	122

The central depression had been transferred across the coast of the Sunderbunds into Central Bengal during the preceding 24 hours, and was to the north of Jessore and west of Dacca. The depression was very small, and was maintained by moderately strong winds. Heavy rain fell over the whole of Bengal.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Bengal	22	1·37	7·97
East Bengal	22	1·63	6·62
South-West Bengal	47	2·57	11·13

Rainfalls exceeding 5 inches were recorded in the following cases:—

Province.	District.	Station.	Rainfall.
East Bengal	Mymensingh	Atiah	6·62
South-West Bengal	Nuddea	Kooshtea	11·13
Ditto	Ditto	Chooadangah	8·28
Ditto	Ditto	Meherpur	6·12
Ditto	Jessore	Jhenidah	8·38
Ditto	Burdwan	Cutwa	7·14
Ditto	Beerbhoom	Soory	5·76

21st August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·808	+·051	SE	2	62
Chittagong	·795	+·036	S	5	75
Jessore	·709	+·022	SSE	22	530
Dacca	·781	+ 087	SE	9	135
Calcutta	·742	+·078	SE	6	115
Saugor Island	·726	+ 067	SE	7	60

The preceding observations show that the depression had filled up. The 4 P.M. observations prove that light winds, generally normal in direction, were again established over the greater part of Bengal. The rainfall of the preceding 24 hours was much smaller in amount, as is shown by the follwing averages :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Bengal	22	0·28	1·15
East Bengal	22	0·16	0·73
South-West Bengal	47	1·36	4·00

The observations of the 22nd show no trace of the cyclonic disturbance, and the rainfall of the previous 24 hours was very small in amount. The disturbance thus terminated on the afternoon of the 21st.

(*No. VI.*)—*Storm of August 27th to the 31st.*—This was a small storm which began to form in the north of the Bay on the 27th. The observations at the coast stations on the morning of the 28th, which first indicated its existence, are given in the following table :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Calcutta	29·725	+·061	NW	5	100
Saugor Island	·704	+ 045	NNE	5	45
Chittagong	·735	—·004	Calm	4	70
Akyab	·717	—·052	NNE	4	135
Cuttack	·734	+·056	W	3	87
Vizagapatam	·740	+·026	NW	1	26

Pressure was generally above the average, and the differences of pressure at the coast stations from Vizagapatam to Akyab were unusually small on the 26th. Pressure gave way at Akyab on the 27th, and was ·05″ below the normal on the morning of the 28th. Winds were unusually light on that day at all the coast stations except Akyab. At Vizagapatam and Saugor Island, more especially, the air motion was very feeble.

The rainfall in Bengal and Orissa was very small in amount, and consisted of a few light local showers, which give an average of ·04 inch in Bengal and ·05 inch in Orissa. A break in the rains, in fact, obtained at this time over the whole of Bengal, Behar, and Orissa.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Bengal	22	0·02	0·39
East Bengal	22	0·07	1·46
South-West Bengal	47	0·04	1·00
Orissa	12	0·05	0·22

29th August.

Station.	Barometer, 10 A.M., reduced to sea-level	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Calcutta	29·676	+·012	NW	3	63
Saugor Island	·648	—·011	NNE	6	55
Chittagong	·685	—·054	E	3	51
Akyab	·717	—·052	SE	7	203
Cuttack	·665	—·013	W	2	51

The barometer had fallen generally over the head of the Bay, and was below the average. It was lowest at Saugor Island. The vortex was some distance to the south of that station, and was advancing in a north-westerly direction. The air motion was considerably below the normal at all the coast stations except Akyab, and indicated very feeble indraught in the west and north quadrants of a cyclonic disturbance. The rainfall was mainly confined to the sea area, and was slightly larger in amount in North and South-West Bengal than on the 28th.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	0·28	1·32
South-West Bengal	47	0·34	1·60
Orissa	12	0·17	1·20

30th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Calcutta	29·627	—·031	W	11	215
Saugor Island	·495	—·164	S	19	175
Chittagong	·832	+·093	SSW	8	88
Akyab	·872	+·103	S	7	210
Cuttack	·616	—·062	W	3	110

The observations indicate that the cyclonic vortex was a few miles to the south-west of Saugor Island. It was advancing towards the Balasore coast, which it crossed about noon of the 30th. The depression at Saugor Island was ·16″, and at the centre probably exceeded ·25″. Moderately strong southerly winds were blowing in the eastern quadrant. At Saugor Island, Akyab, and Calcutta, they were double the normal average strength of the winds in August.

The character of the rainfall is given by the following :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
East Bengal	22	0·78	2·14
South-West Bengal	47	1·13	3·14
Orissa	12	1·12	2·80
North Bengal	22	0·43	1·75

31st August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Calcutta	29·809	+·145	NW	12	225
Saugor Island	·779	+·120	ESE	18	166
Chittagong	·868	+·129	SE	6	100
Akyab	·909	+·140	SE	5	150
Cuttack	·723	+·045	SSW	5	150
Burdwan	·810	+·142	ESE	9	229
Berhampur	·842	+·162	ESE	11	271
Hazaribagh	·739	+·085	E	27	360
Jubbulpore	·677	—·011	NW	5	108

The preceding observations prove that the vortex had been deflected towards the north, and was proceeding through Chutia Nagpur. It was rapidly filling up.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	12	0·31	1·29
Chutia Nagpur	7	2·04	4·30
Central Provinces	72	0·53	4·13
South-West Bengal	47	0·48	6·05

The observations of the 1st September show no trace of the cyclonic circulation. Hence it disappeared on the evening of the 31st in Chutia Nagpur, to which it had given moderately heavy general rainfall during the day.

(*No. VII.*)—*Storm of September 5th to the 11th.*—This storm pursued a somewhat unusual path for the season. It formed near the head of the Bay, and advanced across the North Orissa coast, but, instead of moving over the Orissa Hills, it recurved and marched almost due north through Chutia Nagpur into Behar, where it broke up, after giving moderately heavy rain to the districts over which it passed.

5th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·792	—·042	SE	4	133
Chittagong	·748	—·074	SSW	4	87
Dacca	·730	—·057	Calm	3	65
Jessore	·716	—·048	SW	1	29
Calcutta	·729	—·030	NW	1	21
Saugor Island	·712	—·042	NNW	16	170
False Point	·735	—·030	NW	?	?

The preceding observations show that a small cyclonic circulation was established at the head of the Bay on the 5th. The pressure differences were very small in Bengal, and winds were exceedingly light. A break in the rains had obtained from the 1st over the whole of Bengal. The character of the weather is indicated by the following table, giving the average rainfall in Bengal of the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
East Bengal	22	0·03	0·43
South-West Bengal	47	0·01	0·26
North Bengal	22	0·95	5·83
Behar	38	0·32	5·09
Chutia Nagpur	7	*Nil*	.....
Orissa	13	*Nil*	.....

6th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·832	—·002	S	8	267
Chittagong	·799	—·023	E	6	130
Dacca	·782	—·005	SE	6	130
Jessore	·749	—·035	SE	4	118
Saugor Island	·677	—·077	ENE	15	160
False Point	·680	—·085	N	?	?
Cuttack	·684	—·080	NNE	2	91

The barometer had risen, except at Saugor Island and in Orissa. The depression was approaching the North Orissa coast, and the centre was probably in latitude 20° N. and longitude 87½° E. The weather was unchanged over the greater part of Bengal, where light winds prevailed, with clouded skies, and a moderately high temperature. The following table gives the rainfall at this time :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
East Bengal	22	0·29	1·89
South-West Bengal	47	0·21	0·67
Orissa	13	0·64	2·72
Chutia Nagpur	7	0·18	1·10
Behar	38	0·71	4·35
North Bengal	22	1·22	4·82

7th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·859	+·025	S	7	233
Chittagong	·837	+·015	E	7	152
Dacca	·777	—·010	SE	6	130
Jessore	·718	—·066	E	6	176
Saugor Island	·618	—·136	SSE	9	96
False Point	·605	—·160	NNW	?	?
Cuttack	·574	—·192	W	6	273
Vizagapatam	·740	—·024	W	1	42

The observations show a further fall of the barometer at the Orissa and South Bengal stations, and indicate that the centre was approaching the Orissa coast to the north of False Point. It was hence moving in a NW direction. It crossed the coast in the afternoon. The winds over the whole of Bengal, Behar, Chutia Nagpur, Orissa, and a large portion of the Central Provinces were now dependent on the cyclonic vortex. They were feeble, except in the eastern quadrant. The following gives the average rainfall during the previous 24 hours in the Province of Bengal:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
East Bengal	22	0·58	1·30
South-West Bengal	47	0·54	1·40
Orissa	13	0·80	1·75
Chutia Nagpur	7	0·43	1·11
Behar	38	0·19	1·10
North Bengal	22	0·32	1·30

8th September.

Station.	Barometer, 10 A.M reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Chittagong	29·827	+·005	ESE	9	196
Dacca	·764	—·023	SE	9	196
Jessore	·705	—·079	SE	7	206
Saugor Island	·678	—·076	SSW	17	181
False Point	·706	—·059	SW	?	?
Burdwan	·657	—·109	SSE	7	212
Hazaribagh	·620	—·133	ENE	10	145
Benares	·634	—·107	NE	3	77
Jubbulpore	·730	—·042	NW	3	83
Raipur	·673	—·074	W	8	148
Sambalpur	·620	—·117	W	6	300

The depression is shown by the preceding observations to have been a large and shallow one. The barometric reading at the centre was probably not less than 29·55″. The isobar of 29·7 included the whole of Behar and Chutia Nagpur, and a large part of the Central Provinces, Orissa, and South-West Bengal. The centre was marching to the north-north-west through Chutia Nagpur, and was probably in about latitude 23° north

and longitude 86¼° east. The winds were strongest in the eastern quadrant. The following table gives the rainfall during the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
East Bengal	22	0·79	2·52
South-West Bengal	47	0·34	0·95
Orissa	13	0·66	4·00
Chutia Nagpur	7	0·84	1·63
Behar	38	0·12	1·12
North Bengal	22	1·13	11·32

9th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·704	—·050	SSW	18	192
Burdwan	·683	—·083	S	9	273
Berhampore	·700	—·076	SSW	8	222
Purneah	·683	—·079	ESE	7	318
Durbhunga	?	?	ENE	11	306
Patna	·587	—·163	ENE	2	69
Gya	·569	—·188	NW	5	227
Hazaribagh	·622	—·131	SW	9	130

The disturbance had altered little in character during the previous 24 hours. It was a large and comparatively shallow one. The centre was in South Behar, in about latitude 25° north and longitude 85½° east. The barometer at the centre stood probably a little above 29·55″, and the isobar of 29·7 included the same area as on the preceding day. The winds were of moderate force, the rainfall was diffused over the whole of Bengal, and the amounts received were excessive at several stations in Behar and North Bengal. The following table gives the averages of the preceding 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during 24 hours.
East Bengal	22	1·18	4·95
South-West Bengal	47	0·37	1·69
Orissa	13	0·23	1·05
Chutia Nagpur	7	0·59	1·65
Behar	38	1·29	7·90
North Bengal	22	1·60	7·12

10th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Burdwan	29·625	—·141	SW	7	212
Berhampore	·626	—·150	S	7	192
Jessore	·641	—·143	SSE	6	176
Dacca	·675	—·112	S	11	239
Purneah	·615	—·147	E	5	227
Durbhunga	?	?	ENE	14	389
Patna	·609	—·141	E	2	69
Gya	·578	—·189	NW	4	182
Hazaribagh	·624	—·129	W	9	130

A general fall of the barometer occurred over the whole of India during the preceding 24 hours. Its tendency in Bengal was to equalize pressure, and the barometrical differences were, in consequence, unusually small. There, however, remained slight depression in Behar, and the winds continued to circulate cyclonically over the area of depression. The centre of convergence was probably between Gya and Patna, but the winds generally were less regular than before. Rain continued to fall over the whole of Bengal and Behar. North and East Bengal, Behar, and Chutia Nagpur received heavy rain. The following table gives the averages for the divisions of Bengal:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
East Bengal	22	1·59	5·79
South-West Bengal	47	0·56	1·95
Orissa	13	0·72	1·78
Chutia Nagpur	7	1·19	3·70
Behar	38	1·13	3·60
North Bengal	22	1·53	5·42

11th September.

Station.	Barometer, 10 A.M, reduced to sea-level.	Difference from normal.	Wind.		
			Direction, 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Burdwan	29·599	—·167	W	6	182
Berhampore	·544	—·232	SW	7	192
Jessore	·608	—·176	SW	3	88
Dacca	·615	—·172	SW	9	196
Calcutta	·641	—·118	NE	3	64
Purneah	·583	—·179	NE	6	273
Durbhunga	?	?	ENE	8	222
Gya	·610	—·147	NW	4	182
Hazaribagh	·651	—·102	WNW	16	282

During the previous 24 hours, a local fall of the barometer had occurred at Berhampore, and the position of minimum pressure was, in consequence, transferred to that station. This accompanied, and was apparently due to, heavy local rainfall in the northern districts of South-West Bengal. The air motion had increased at Berhampore, and there was a marked tendency to local cyclonic circulation in the neighbourhood. The general cyclonic motion, however, continued, differing little in position, character, and strength at 10 A.M. from that which it was on the 10th, and the general centre of indraught was apparently in the same position as on the 10th. The average rainfall of the preceding 24 hours is given in the following table:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	22	2·22	5·16
South-West Bengal	47	1·52	5·48
Orissa	13	0·14	0·57
Chutia Nagpur	7	2·38	3·54
Behar	38	1·06	5·60
North Bengal	22	1·13	4·67

The 10 A.M. observations of the 12th show that the depression had filled up, and that the cyclonic circulation was no longer in existence. The rainfall of the 24 hours preceding 6 P.M. of the 12th were small in amount compared with that of the previous three days. The storm hence terminated on the evening of the 11th.

(*No. VIII.*)—*Storm of November 2nd to the 5th.*—This storm was the only one which occurred after the south-west monsoon had retreated from Northern India. It was a very imperfectly developed storm, and is included mainly because it illustrates a well-known fact in Indian meteorology, *viz.*, that the conditions for the occurrence of storms in the Bay during the months of October, November, and December are very unfavourable if the north-east monsoon sets in early on the Coromandel coast, and gives copious and regular rain, and hence that in such years storms rarely occur. The following table gives the observations which first indicated its formation :—

1st November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·963	+·003	SW	4	74	0·16
Port Blair	·979	+·021	SE	?	?	0·21
Akyab	30·031	+·030	ENE	2	91	...
Vizagapatam	·020	—·004	NE	1	40	0·70
Madras	29·970	—·023	N	4	59	4·80
Negapatam	·972	+·005	WSW	1	18	0·78

During the preceding two or three days, the north-easterly winds on the west coast of the Bay had been diminishing in strength. On the 1st of November, winds were unusually light over the whole of the south and centre of the Bay. The recurvature of the south-west winds over the centre of the Bay tended to give a feeble and somewhat irregular cyclonic circulation. The rainfall, from the 30th to the 1st, in the Madras Presidency, as indicated by the returns of the meteorological stations, is given in the following table :—

	Average rainfall of previous 24 hours in the Madras Presidency.	Heaviest rainfall of previous 24 hours in the Madras Presidency.
October 30th	0·38	1·46
„ 31st	0·40	1·56
November 1st	0·74	4·80

Hence the rainfall was increased slightly in amount during this period.

2nd November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·981	+·021	SE	3	56	...
Port Blair	·980	+·022	SE	6	82	0·10
Rangoon	30·017	+·033	S	3	68	...
Akyab	·010	+·009	SSE	2	91	0·05
Vizagapatam	29·947	—·077	ENE	1	40	0·10
Masulipatam	·950	—·063	NE	1	?	0·01
Madras	·960	—·033	N by E	4	59	0·25
Negapatam	·936	—·031	WNW	1	18	...

Pressure was above the average on the Aracan coast, and below it on the Coromandel coast. Although the humid winds blowing into the Bay from the south were very feeble, they were continued as south-east, east, and north-east light winds over the centre of the Bay, and discharged rain over the Coromandel coast and adjacent districts, but the amount was considerably smaller than on the previous three days. The following gives rainfall data for this day :—

Presidency.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
Madras	0·19	1·39
Bengal	*Nil*	0·08

3rd November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·980	+·020	ESE	1	19	...
Port Blair	·966	+·008	SSE	7	96	0·67
Akyab	·949	—·052	NE	4	182	2·25
Chittagong	·921	—·099	ENE	2	61	0·11
Saugor Island	·881	—·155	NNW	7	117	...
False Point	·904	—·147	NNE	8	129	0·03
Vizagapatam	·913	—·111	ESE	3	120	...
Madras	·961	—·032	N by W	6	88	0·01
Negapatam	·954	—·013	WNW	0	0	0·28

A considerable diminution of pressure had occurred at the stations on the north and north-west coasts, indicating that an area of depression was forming between the Arakan and Ganjam coasts. The wind circulation was somewhat irregular on this supposition, but the meteorology of the 4th and 5th shows that this was due to the ill-defined character of the disturbance. Winds were exceedingly light in the south of the Bay, as evidenced by the Nancowry and Negapatam returns, hence proving that there was no large influx of aqueous vapour from the south. The following table gives average rainfall data for the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Madras Presidency	12	0·37	2·20
East Bengal	22	0·34	2·21
South-West Bengal	47	0·04	0·52
North Bengal	23	0·03	0·65

4th November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·964	+·004	SE	2	37	...
Port Blair	·961	+·003	S	5	69	0·01
Akyab	·871	—·130	S	6	273	6·65
Chittagong	·882	—·138	NE	3	91	0·03
Saugor Island	·877	—·159	NNW	7	117	...
False Point	·902	—·149	N	7	113	...
Vizagapatam	·931	—·093	W	1	40	...
Madras	·960	—·033	N	2	29	0·01
Negapatam	·946	—·021	NE	0	0	...

The changes of pressure were not great. The area of minimum pressure occupied the north-east angle of the Bay, and the winds as far south as Vizagapatam and Bassein showed that the cyclonic circulation extended from the Bengal coast to latitude 16° north. Further south, very light winds prevailed, but they were normal in direction, more especially on the Coromandel coast, where they were from north at Madras, and north-east at Negapatam. The absence of strong winds to the south of the depression is very significant. The following table gives the average rainfall of the preceding 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Madras Presidency	12	0·36	...
East Bengal	22	0·03	0·16
South-West Bengal	47	0·04	0·68
North Bengal	23	Nil	Nil.

Heavy rain was received on the Aracan Coast. Akyab registered 6·65 inches for the previous 24 hours.

5th November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·960	+·002	W	5	69	...
Akyab	·946	—·055	ESE	4	182	0·03
Chittagong	·894	—·126	NE	3	91	...
Dacca	·936	—·092	NW	2	105	...
Calcutta	·958	—·094	N by W	3	107	...
Saugor Island	·939	—·097	NE	4	67	...
False Point	·963	—·088	NNW	4	69	...
Vizagapatam	975	—·049	NNW	1	40	...

The preceding observations establish that the depression was filling up, and the air circulation less regular than on the 4th. The barometer was lowest at Chittagong. Rain had, however, ceased to fall in connection with it, and the vortex completely disappeared during the afternoon of the 5th, as there was no trace of its existence on the morning of the 6th. No rain fell in Bengal or Aracan on the 5th, whereas rain began to fall more copiously again in Madras. Coimbatore and Madura each registered 2 inches on the 6th, and several stations 1 inch. The storm hence broke up on the 5th.

The above gives a brief account of the chief features of the south-west monsoon storms that were generated in the Bay of Bengal during the year 1877. There are several important features of these storms which it is desirable to note, as they were more or less dependent on the special or abnormal meteorological conditions of the year.

1st.—The Madras storm of May was a remarkable one. It was due to the first rush of the south-west monsoon winds into the Bay, over the centre and east

of which pressure was unusually high, and slightly in excess of the pressure on the northern and western coasts. It advanced west-north-westwards to the coast north of Madras, and then recurved and moved along the base of the Eastern Ghats, Orissa Hills, and Chutia Nagpur Plateau into Behar, and gave unusually heavy rain to the whole area over which it passed. It was essentially a cyclone of the May transition period, and of low elevation.

2nd.—The storm of July, although of little importance at sea, had a protracted existence on land. It advanced across the head of the peninsula, along the ridge of excess pressure, which defined the northern edge of the Bombay monsoon current at the time.

3rd.—There was a rapid succession of five storms between the beginning of August and the middle of September, which were all generated near the head of the Bay, and passed northwards into Bengal. Four crossed the coast to the east of Saugor Island. The fifth advanced across the Balasore coast into North Orissa, and passed through Chutia Nagpur into Behar. It is very remarkable that not a single storm crossed the Orissa hills into the Central Provinces during this period.

4th.—The most abnormal feature, on the whole, was the almost entire absence of storms in the Bay during the months of October, November, and December. One feeble and ill-defined whirl formed in the first week of November and advanced to the north-east, but broke up shortly after crossing the coast near Chittagong.

1878.

Many of the more important abnormal features of the year 1878 were similar in character to those of the previous year 1877, and were, in fact, due to the continuance of the same general meteorological conditions over a considerable part of the country. The cold weather of 1877-78, like its predecessor, was characterized by unusually heavy snowfall over the Himalayas. Hence many of the features of the first five months of 1877 and 1878 were similar in character. Temperature was considerably below the normal in the month of January over the whole of Northern India, and above it in Southern India. This contrast of temperature conditions disappeared during the month of February, and was replaced by excessive heat over the whole of India in March. April and May were distinguished by a succession of storms, which gave excessive rain over the whole of Northern India, and reduced the temperature very considerably below the normal. The months of June and July were marked by excessive temperature, due to prolonged delay in the establishment of the rains over Northern India. During the remainder of the year, the temperature variations were comparatively small and unimportant.

The most remarkable feature of the previous year, *viz.*, general excessive pressure over the whole of the Indian area, was continued until the end of August 1878, when a sudden change occurred, which gave deficient pressure over the same area during the remainder of 1878, the whole of 1879, and until the month of June 1880. The remarkable persistence of the most general abnormal features of the distribution of pressure in the Indian area and the sudden transition to the opposite condition are facts which are as yet quite unex-

plained. The local abnormal barometric variations of the year 1878 differed very considerably from those of 1877. Pressure was, before and during the south-west monsoon rains, relatively in excess to a considerable extent in the East of the Bay, as represented by the Bay Islands, and in Arakan, Cachar, and Assam. There was thus a ridge of unusually high pressure which ran up the East of the Bay through Cachar into Assam, and separated an area of somewhat lower pressure in the east (covering probably the greater part of Burmah) from another in the west, over which the pressure diminished westwards as far as the Western Ghats and the Bombay Coast, where there was an unusual deficiency of pressure, which contrasted strikingly with the excessive pressure which obtained in the same districts in 1876 and the greater part of 1877. Pressure in Northern India, Behar, Chutia Nagpur, and Orissa was in excess, but to a less extent than in Eastern Bengal and Assam. The remarkable change from excessive to deficient pressure over the Indian area which occurred at the end of August and beginning of September 1878 was not accompanied by any important change in the relative distribution or abnormal variations of pressure in India. The rainfall of the year was above the average. It was excessive in Western India (including Sind, Guzerat, Khandesh, and the Northern Dekhan), and was considerably below it in Arakan, Pegu, and Tenasserim. Moderately heavy rain was received over the whole of Northern India in April and May. The south-west monsoon rains set in abundantly in Eastern Bengal in June. June and July were very dry months in Northern India, and hot westerly winds prevailed over the whole of the North-Western Provinces. Hence general rainfall extended over the Gangetic plain only as far as Behar. Average or excessive rain fell over nearly the whole country during the months of August and September. The rains ceased earlier than usual in Northern India. The north-east monsoon set in feebly on the Coromandel coast in the latter part of October. The accompanying rainfall was deficient over the whole of Southern India, except the Northern Districts of Madras, including the Northern Circars and Godavery, which were visited by a succession of storms between the third week of October and the first week of December.

(*No. IX.*)—*Storm of July 20th to the 30th.*—This cyclonic storm formed considerably further south in the Bay than is usual in July. It advanced across the coast of the Circars, and travelled across the head of the peninsula in a general west-north-west direction for several days, and disappeared on the 30th in the north-western districts of Rajputana. The observations of the 20th present the first feeble indications of its formation in the Bay:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·742	+·008	E	?	?
False Point	·617	−·008	SE	5	50
Cuttack	·609	−·012	E	2	50
Vizagapatam	·587	−·078	WNW	?	?
Masulipatam	·620	−·080	W	?	?
Madras	·719	−·074	SSW	6	60

Pressure was hence below the average over the Bay. The deficiency was greatest in the neighbourhood of the mid-west coast stations. The air motion was light, and below the average at all the adjacent coast stations. There was hardly any rain falling in Bengal or Orissa. Moderate rain, due to the Bombay branch of the monsoon current, was received in the Central Provinces. The character of the rainfall is given roughly by the following average data :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	47	0·06	0·55
Orissa	13	0·09	0·44
Central Provinces	72	0·63	2·00

21st July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·654	+·029	SE	4	40
Cuttack	·628	−·007	SSE	2	51
Vizagapatam	·609	−·056	SW	?	?
Masulipatam	·692	−·007	W	?	?
Sambalpur	·547	−·069	SE	4	133
Raipur	·583	−·032	Calm	5	44

Pressure had increased during the past 24 hours, and the depression, as estimated by the observations at the coast stations, was smaller than on the 20th. Its position is not clearly defined by the land observations. It had probably moved west-north-westwards, but the indications of its existence were even slighter than on the 20th. The winds were feebler than on the preceding day. Light showers fell during the previous 24 hours in South-West Bengal, Orissa, and the Central Provinces, which gave a slightly larger average rainfall to the Central Provinces than to Orissa and Bengal :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	47	0·17	1·57
Orissa	13	0·10	0·30
Central Provinces	70	0·46	4·69

22nd July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·720	−·009	ENE	4	110
Saugor Island	·639	+·043	E	9	72
False Point	·638	+·013	ENE	5	50
Vizagapatam	·574	−·091	W	1	23

The observations show that little change had apparently taken place in the depression at the cyclonic vortex which was now approaching the coast between False Point and Vizagapatam. It had, therefore, probably moved to the west-north-west. The air motion was, as hitherto, below the average, more especially at Vizagapatam, where only 24 miles of wind were registered for the previous day. The indraught to the area of depression in the western and northern quadrants was thus exceedingly feeble, although cyclonic circulation was fully established over the greater part of the north of the Bay. The rainfall of this day was similar in character to that of the 21st, as is shown by the following averages :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	47	0·18	1·07
Orissa	13	0·61	1·30
Central Provinces	72	0·57	3·24

23rd July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·741	+·012	S	4	110
Saugor Island	·533	—·063	ENE	7	57
False Point	·545	—·080	SE	8	80
Cuttack	·510	—·111	NE	3	75
Vizagapatam	·513	—·152	WNW	2	46
Nagpur	·555	—·098	N	3	42
Chanda	·618	—·090	WNW	?	?

The cyclonic vortex was at 10 A.M. of this day to the north of Vizagapatam, and had crossed the Ganjam Coast early in the morning. The depression at the centre was not large, as it only amounted to ·15″ at the nearest observing station, Vizagapatam. The wind velocities indicate circulation of the air of very slight intensity over the western half of the cyclonic area, over which it barely averaged half of the normal strength of the ordinary July winds. The rainfall in connection with it over the land was now increasing. The Bombay branch of the monsoon current gave heavy rain over the west and south-west portions of the cyclonic disturbance. Rainfalls, exceeding 3 inches, were recorded at Vizagapatam 5·6 inches, and at the following stations in the Central Provinces :—

	Inches.
Shahpur	4·62
Multai	3·65

The following table gives rainfall averages similar to those of the preceding days :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
South-West Bengal	47	0·33	1·48
Orissa	13	0·74	1·83
Central Provinces	73	0·56	62

24th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Vizagapatam	29·548	—·117	W	9	210
Cuttack	·496	—·125	SSW	5	125
Saugor Island	·556	—·040	SSE	12	100
Hazaribagh	·561	—·021	E	14	165
Sutna	·516	—·058	NE	?	?
Seoni	·526	—·102	NW	?	?
Nagpur	·548	—·105	W	5	70
Raipur	·448	—·167	NE	?	?

The observations establish that the centre was at 10 A.M. of the 24th in the Central Provinces, some little distance to the south of Raipur, where the barometric depression was greatest (·17″). The centre had hence advanced about 180 miles in a west-north-westerly direction during the previous 24 hours. The winds were considerably stronger at the coast stations, and were generally above their normal force. Over the western and southern quadrants, they still appear to have been very weak, although

rain was chiefly falling in this portion of the depression, brought up by the Bombay monsoon current. Heavy rain was almost entirely confined to the Central Provinces, as is shown by the following table :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	13	0·54	2·11
Central Provinces	73	1·30	6·33

Rainfalls exceeding 5 inches were registered at the following stations in the Central Provinces :—

District.	Station.	Rainfall.
Bhandwara	Bhandwara	6·01
Chanda	Chanda	5·50
„	Mul	5·90
Betul	Shahpur	6·33
Narsinghpur	Narsinghpur	5·31

25th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Raipur	29·546	—·069	SW	?	?
Hazaribagh	·561	—·021	E	15	180
Allahabad	·533	—·029	E	?	165
Sutna	·510	—·064	N	?	?
Jubbulpore	·570	—·052	NW	4	74
Nagpur	·613	—·040	W	7	100

The observations of the 25th establish that the depression was smaller in amount and extent than on the previous day. The chart of that day also shows that the vortex was still in existence, but that it was not so clearly defined as on the 24th. The centre was apparently in the high ground to the east of Jubbulpore. The winds in the eastern half of the cyclonic area (represented by Hazaribagh and Allahabad) were considerably above their ordinary strength. The winds were, as on the 23rd and 24th, feeble over the western half. Heavy rain fell in the districts of the Central Provinces near, and to the west of, the vortex. Rainfall exceeding 5 inches was registered at one station only in

the Central Provinces, namely, Mohpani in the Narsinghpur district, which received 7 inches. The following gives average rainfall data similar to those of the preceding days:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	13	0·76	3·55
Central Provinces	74	0·80	7·00
Behar	40	0·15	1·42
North-Western Provinces	168	0·10	5·50

26th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Raipur	29·514	—·071	SW	?	?
Cuttack	·576	—·045	S	3	75
Calcutta	·623	+·024	SE	6	95
Hazaribagh	·542	—·040	E	11	130
Benares	·581	+·010	NE	9	185
Sutna	·551	—·023	N	?	?
Jubbulpore	·589	—·033	WNW	5	93
Nagpur	·627	—·026	W	5	70

The preceding observations show in the first place that the vortex in the Central Provinces was in nearly the same position as on the 25th, but that the depression was smaller in amount, and extended over a larger area. It was at this time filling up. The fall of the barometer at Cuttack and Raipur was, as shown more clearly by the 4 P.M. observations of the 25th, due to the passage of a very slight depression across the north of Orissa coast on the evening of that day, which gave heavy rain to the whole of Orissa on the 26th. The rainfall in the Central Provinces was confined to heavy showers in the northern districts. Balaghat received 7·26 inches. The following gives average rainfall returns for the 26th:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	13	2·49	6·60
Central Provinces	76	0·96	7·26
Behar	40	0·45	2·18

Rainfalls above 5 inches were registered at the following stations :—

	Inches.
Sora in the Balasore district of Orissa	6·60
Balaghat in the Balaghat district of the Central Provinces	7·26

27th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Cuttack	29·605	—·016	SW	1	29
Hazaribagh	·604	+·021	E	18	209
Allahabad	·521	—·041	E	11	297
Sutna	·487	—·087	E	?	?
Jubbulpore	·465	—·157	NE	4	74
Seoni	·539	—·089	SW	?	?
Nagpur	·589	—·064	W	10	141
Raipur	·548	—·067	SW	13	114
Neemuch	·621	—·004	N	?	?

The second smaller cyclonic vortex advanced rapidly during the preceding 24 hours, and merged before 10 A.M. of the 27th with the previously formed one. This was accompanied by a considerable fall of the barometer and heavy rain over the northern districts of the Central Provinces. The centre of the united cyclonic disturbances was in the immediate neighbourhood, and to the north-east, of Jubbulpore, where the barometric depression had increased from ·03″ on the 26th to ·16″ on the 27th. The air motion was distinctly cyclonic over the Central Provinces, Chutia Nagpur, and the adjacent districts of the North-Western Provinces and Behar. It was very feeble in the western quadrant, as is proved by the Jubbulpore wind returns. Heavy rain fell in the north-western districts of the Central Provinces. Rainfalls exceeding 5 inches were recorded at the following stations, all in the Central Provinces :—

Province.	District.	Station.	Rainfall.
Central Provinces	Balaghat	Behir	5·60
„	Betul	Badnur	7·75
„	„	Shahpur	6·50
„	„	Amla	5·60

The following table gives average rainfall data of the 27th :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	13	0·93	2·47
Central Provinces	76	1·23	7·75
Behar	40	0·33	1·80

28th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jubbulpore	29·570	—·052	SW	5	93
Sutna	·498	—·076	S	?	?
Jhansi	·466	—·095	ENE	?	?
Hoshangabad	·434	—·217	W	?	?
Khandwa	·532	—·123	W	15	160

The cyclonic vortex had advanced nearly due westward during the previous 24 hours, and was now in Central India to the north of Jubbulpore, and probably between Jhansi and Hoshangabad. The depression was apparently as large as on the 27th. The winds in the southern quadrant, as indicated by the Khandwa returns, had strengthened slightly. Heavy rain continued to fall in the northern districts of the Central Provinces. It was now extending northwards and westwards to Central India. Rainfall of 4 inches or more was registered at Shahpur in the Betul district of the Central Provinces (6·03 inches), and Pachmarhi (4·84 inches). The average rainfall of the previous 24 hours of the Central Provinces, Orissa, and Behar is given below.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	12	0·13	1·16
Central Provinces	70	1·10	6·03
Behar	40	0·53	1·85

29th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Indore	29·511	—·155	SW	?	?
Jhansi	·454	—·107	SE	?	?
Agra	·491	—·069	ESE	?	?
Delhi	·537	+·003	ESE	12	211
Ajmere	·446	—·134	NE	6	?
Deesa	·532	—·087	Calm	0	?
Neemuch	?	?	WSW	?	?

These observations show that the cyclonic disturbance had been transferred to Central Rajputana, and that the vortex was between Ajmere and Neemuch. The depression was smaller than on the 28th, and was now rapidly filling up. Moderately heavy rain fell at the nearest stations to the south of the vortex. Neemuch received 3·20 inches and Mount Abu 6·2 inches.

The following table gives the average rainfall of the Central Provinces during the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Central Provinces	70	0·65	2·90

30th July.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Jacobabad	29·462	—·034	E	4	83	0·09
Kurrachee	·488	—·085	NNE	11	61	0·78
Rajkot	·559	—·097	SW	21	130	2·26
Deesa	·557	—·062	S	?	?	0·12
Ajmere	·470	—·110	S	5	72	3·45
Mooltan	·490	—·012	NE	6	176	0·15

The depression was smaller in amount than on the 29th, and had advanced in a west-north-westerly direction during the previous 24 hours. The centre was now approaching the north Sind frontier. The cyclonic circulation was feebler than on the 29th, and was commencing to break up. Moderately heavy rain had fallen at the stations in the western and southern quadrants, and light showers in the area to the north and east of the centre.

The cyclonic disturbance filled up rapidly during the afternoon of the 30th, and disappeared before 10 A.M. of the 1st of August.

This storm was characterized by the following special features :—

1st.—It was formed off the Ganjam Coast, much further south than is usual in July.

2nd.—It was comparatively feeble in the Bay, but acquired increased intensity after crossing the Orissa hills, and marched in a curved path through the Central Provinces.

3rd.—It was followed by a second vortex, which delayed the advance of the first vortex for some time in the north-eastern districts of the Central Provinces, and merged with it, when the combined disturbance marched rapidly across the continent, and broke up near the eastern frontier of North Sind.

The following data give approximately path and rate of motion of the centre:—

Date.	Position of Centre.		Distance passed over in previous 24 hours
	Latitude N.	Longitude E.	
July 21st	18° 0′	86° 30′	...
„ 22nd	18° 45′	85° 0′	110
„ 23rd	19° 40′	83° 40′	120
„ 24th	20° 50′	81° 30′	160
„ 25th	23° 10′	80° 50′	165
„ 26th	23° 50′	80° 50′	45
„ 27th	24° 10′	80° 50′	25
„ 28th	25° 20′	79° 0′	145
„ 29th	26° 0′	75° 0′	270
„ 30th	27° 0′	71° 0′	270

(*No. X.*)—*Storm of August 1st to the 4th.*—This was a small cyclonic storm which formed in the Bay probably on the 31st of July. Its existence was first indicated by the observations of the 1st of August.

1st August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·581	—·188	SE	5	156
Saugor Island	·533	—·126	NE	7	67
False Point	·536	—·147	NE	6	66
Vizagapatam	·619	—·095	W	3	89

The centre was probably to the east-south-east of False Point. The Akyab returns indicate the prevalence of strongish winds in the eastern half of the cyclone, whilst the observations at the remaining stations show that over the western half of the depression

the circulation was feeble. Light rain was falling in Bengal or Orissa. In the Central Provinces, moderate showers gave an average rainfall for the previous 24 hours slightly exceeding half an inch.

	Number of stations.	Average rainfall of 24 hours.	Heaviest rainfall of previous 24 hours.
East Bengal	24	0·04	0 40
South-West Bengal	47	0·06	0·72
Orissa	12	0·15	1·10
Central Provinces	75	0·64	4·00

2nd August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·637	—·132	S	6	188
Saugor Island	·549	—·110	ENE	7	65
False Point	·525	—·158	ENE	8	88
Vizagapatam	·548	—·166	W	1	29

The observations indicate that the vortex was approaching the west coast of the Bay. The barometric depression at False Point and Vizagapatam was greater than elsewhere. The air motion was similar in character to that which obtained on the 1st. Moderate rain was falling in Orissa, due to the cyclone. In the Central Provinces showers continued to fall, which gave an average rainfall similar to that of the 1st. The following table gives average results for comparison:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·32	4·02
South-West Bengal	47	0·07	0·77
Orissa	12	0·73	1·57
Central Provinces	75	0·63	6·80

3rd August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·563	—·096	ESE	13	122
False Point	·537	—·146	ESE	11	121
Cuttack	·521	—·157	ENE	4	129
Sumbalpur	·486	—·163	NE	?	?
Nagpur	·588	—·119	NE	5	91
Vizagapatam	·581	—·133	W	2	59

The cyclonic vortex crossed the Orissa coast on the morning of the 3rd to the south of False Point, and was at 10 A.M. between Pooree and Cuttack. The depression at Cuttack was ·16″. The wind returns show that the circulation was, as on the 1st and 2nd, moderate in the eastern half of the cyclonic area, and feeble and considerably below the average force of the ordinary winds of the season over the western half.

The rainfall of the previous 24 hours was moderate in amount, as is shown by the following average rainfall returns:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·27	1·51
South-West Bengal	47	0·31	1·16
Orissa	12	0·59	2·56
Central Provinces	75	0·38	2·97

4th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Hazaribagh	29·576	—·078	E	13	176
Sutna	·517	—·129	NE	?	?
Jubbulpore	·540	—·150	W	1	19
Nagpur	·557	—·150	SSW	5	91
Raipur	·527	—·147	S	?	?

The observations for the day prove that, although there was a considerable depression of the barometer, it was nearly uniform over a considerable area. This confirms what is suggested by the charted observations, and more especially by the wind directions, that the centre was not clearly defined, and that the disturbance was breaking up. As might be expected, the rainfall was not large in amount. The following table gives its general character :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·21	0·77
South-West Bengal	47	0·19	0·97
Orissa	12	0·21	0·40
Central Provinces	68	0·64	3·60

The returns for the 5th show that there was no cyclonic circulation in the Central Provinces on the morning of that day. Hence the vortex broke up during the afternoon of the 4th.

(*No. XI.*)—*Storm of August 6th to the 8th.*—This was a small storm, which was generated on the afternoon of the 5th under similar conditions to the previous. The wind directions of the coast stations at the head of the Bay first indicated its existence on the morning of the 6th.

The following are the 10 A.M. observations of that day :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·681	—·088	SSE	4	125
Chittagong	·656	—·083	SSE	6	95
Saugor Island	·524	—·135	ENE	6	56
False Point	·528	—·155	N	5	?
Vizagapatam	·587	—·127	W	4	115

The central depression was to the south of Saugor Island. The barometric depression was greatest at False Point, for which it was ·16″. The air movement was below the average on the Bengal coast. Little or no rain was falling in Bengal. Heavy rain occurred in Orissa, the average for the 24 hours preceding 6 P.M. being 1·73 inch.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·23	2·61
South-West Bengal	47	0·23	2·16
Orissa	12	1·73	12·20

7th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Cuttack	29·536	—·142	S	3	100
False Point	·552	—·131	S	8	89
Saugor Island	·581	—·078	ESE	11	100
Hazaribagh	·562	—·092	E	13	150
Raipur	·529	—·145	SW	5	85
Sambalpur	·425	—·224	S	2	70

The position of the centre at 10 A.M., as determined from the observations, was to the west-north-west of Sambalpur. The centre crossed the Balasore coast late on the previous evening, or early on the morning of the 7th, and advanced nearly due west. The air motion was now generally above the average in the eastern quadrant, but was nowhere excessive. The following gives the average rainfall of the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·76	2·61
South-West Bengal	47	0·48	4·10
Orissa	12	1·03	4·66
Central Provinces	72	0·80	5·00

8th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Hazaribagh	29·615	—·042	SE	14	190
Raipur	·639	—·035	S	8	125
Sambalpur	·624	—·025	SW	3	140
Nagpur	·633	—·079	W	9	165
Vizagapatam	·698	—·017	W	3	88
Cuttack	·679	—·003	SW	7	229
Sutna	·498	—·148	E	13	169
Jubbulpore	·533	—·157	W	5	104

The depression did not acquire additional energy in the Central Provinces, and was breaking up on the morning of the 8th, when the cyclonic circulation was very indistinctly marked, excepting in a small area including Sutna and Jubbulpur, between which stations the vortex was passing at 10 A.M. The southerly winds at the head of the Bay were still above their normal force, and were bringing up moderately heavy rain to Bengal. The rainfall in the Central Provinces was small in amount. The cyclonic disturbance disappeared before the morning of the 9th. The following table gives average rainfall data for the 24 hours preceding 6 P.M. of the 8th :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
East Bengal	24	2·04	7·42
South-West Bengal	47	1·22	4·16
Orissa	12	0·14	0·80
Central Provinces	75	0·41	2·44

(*No. XII.*)—*Storm of September 13th to the 21st.*—This is an example of a class of storm of which one or two cases occur during every rainy season. They originate in the Bay, cross the Orissa Coast, and then advance along the head of the peninsula, in the narrow belt, which usually forms a trough of low pressure, and demarcates the Bombay westerly monsoon current from the easterly current up the Gangetic Plain, which is the continuation of the Bay of Bengal monsoon current. They occasionally cross over the entire breadth of the continent, giving heavy rainfall during their course to the Central Provinces, Central India, Rajputana, and the northern districts of Bombay, Guzerat, and Cutch. In such cases they appear to fill up, when the centre is in the immediate neighbourhood of the coast of the Arabian Sea. They have been known to disappear beyond the coast, passing into the Arabian Sea. The present is a very complete example of its kind. The observations of the morning of the 13th of September first show the establishment of the cyclonic circulation which gave rise to this storm. It is probable that it began to form during the previous day. The 10 A.M. observations at the neighbouring coast stations are as follow :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·653	—·170	SSE	4	133
Chittagong	·660	—·156	NE	3	60
Saugor Island	·587	—·168	NE	6	66
False Point	·608	—·162	NNW	6	86

The barometer was below the average by nearly equal amounts, showing that the central disturbance was probably nearly midway between Akyab and False Point. Winds were below their normal strength, except at Akyab in the eastern quadrant, where they were somewhat stronger than usual. The rainfall over the coast area to the north and west was not large in amount. A partial break in the rains was established in Bengal, the Central Provinces, Behar, and the greater part of the North-Western Provinces.

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during previous 24 hours.
East Bengal	24	0·55	3·10
South-West Bengal	47	0·36	1·77
Orissa	12	0 39	1·30

14th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·712	—·129	S	6	200
Chittagong	·706	—·110	Calm	2	40
Saugor Island	·632	—·123	ENE	7	78
False Point	·598	—·172	NE	6	86
Vizagapatam	·641	—·119	WNW	3	150

The observations show that the barometer had risen generally, and that the central depression was now approaching the Orissa Coast, and was perhaps 80 miles to the south-east of False Point. The winds at the nearest stations were feeble and below their normal strength, except at Akyab, where they had increased in force. Moderately heavy rain was now falling in South-West Bengal and Orissa. The latter received an average of 1·09 inch for the 24 hours preceding 6 P.M. Light showers were falling in the Central Provinces. The average rainfall of the previous 24 hours is shown in the following table:—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
East Bengal	24	0·46	2·60
South-West Bengal	47	0·44	4·00
Orissa	12	1·09	2·85
Central Provinces	76	0·26	3·80

15th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage
False Point	29·647	—·123	S	7	100
Cuttack	·625	— 147	ESE	6	200
Sambalpur	·617	— ·064	NW	3	150
Hazaribagh	·725	—·032	E	14	200
Jubbulpore	·680	—·097	NE	4	100
Nagpur	·685	—·094	NW	4	100
Vizagapatam	·652	—·108	W	1	50

The cyclonic vortex crossed the Orissa Coast a little to the south of False Point on the afternoon of the 14th, and continued to travel nearly due westward. At 10 A.M. of the 15th, the centre was to the west of Cuttack, and was probably crossing the Orissa hills, thus causing some irregularity in the winds. The depression at this time was comparatively small, and almost certainly did not exceed two-tenths of an inch in amount at the centre. The wind velocity at the nearest stations to the north and east was considerably greater than the normal, whilst to the west and south, winds were barely up to their average force. The air circulation, as indicated by the wind directions at Cuttack and Sambalpur, was somewhat irregular. The following table gives average rainfall results :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
South-West Bengal	47	0·23	1·28
Orissa	12	0·62	1·35
Central Provinces	67	0·89	4·54

The area of rainfall was now extending westwards. It was not so large in amount as on the 14th. The Central Provinces received the heaviest amounts, and the greatest average fall.

16th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Raipur	29·620	—·134	SW	4	74
Sutna	·634	—·110	E	14	200
Jubbulpore	·618	—·159	NE	2	54
Nagpur	·623	—·156	W	4	95

The observations indicate that the central depression at 10 A.M. was in the central districts of the Central Provinces between Raipur, Nagpur, Seoni and Jubbulpur, and probably midway between Raipur and Seoni. The cyclonic circulation was as clearly marked as hitherto. The barometric depression at the centre was apparently about two-tenths of an inch and the same in amount as on the 14th and 15th. The air motion in the north and west quadrants was, as hitherto, feeble and either below or barely up to the average. Moderately strong westerly winds prevailed in the southern quadrant, and gave very heavy rain to a large portion of the Central Provinces, as is shown by the following table:—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Orissa	12	0·46	0·49
Central Provinces	67	1·12	6·20
Chutia Nagpur	9	0·32	0·68

The largest fall at this time was observed in front, and to the south-west of the vortex, at Nagpur, which received 6·2 inches.

17th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jubbulpore	29·606	—·171	S	7	160
Hoshangabad	?	?	ESE	0·4	20
Khandwa	538	—·267	W	6	105
Amraoti	·594	—·145	SW	7	185
Nagpur	·620	—·159	W	6	135
Seoni	·612	—·110	SE	2	63

The preceding observations indicate that the cyclonic vortex was at 10 A.M. of the 17th, between Nagpur and Khandwa, and probably in the Nimar district of the Central Provinces. It had thus moved in a westerly direction during the previous 24 hours, and was crossing the Mahadeva Hills. The depression was now increasing in amount, and the indraught in the western quadrant, so far as can be judged from the observations, was above the normal air motion. Moderately heavy rain was falling in the northern and western quadrants. The following table gives average rainfall data for the 17th:—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Orissa	12	0·55	1·60
Central Provinces	76	0·48	3 50
Chutia Nagpur	9	0·19	0·53

18th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Khandwa	29 513	—·292	S	4	70
Indore	·543	—·219	ESE	?	?
Malegaon	·485	—·297	SW	7	85
Buldana	·538	—·234	S	8	120
Akola	·572	—·227	WSW	4	75
Amraoti	·567	—·172	SW	7	175
Surat	·494	—·282	WSW	?	?
Rajkot	·567	—·205	WSW	10	107

The preceding returns show that the disturbance had intensified considerably, and that the barometric depression was much larger in amount than it had hitherto been. It was three-tenths of an inch at Surat and Malegaon. The centre was now in North Bombay in the Ahmedabad district, to the north-east of Surat. Strong winds were blowing in the west quadrant. The winds at stations in the east quadrant were light and below the average. Heavy rain was now falling in Guzerat, and the northern districts of Bombay, including Surat and Ahmedabad. The daily rainfall data for North Bombay are not available. Surat received 6·45 inches, and Rajkot 7·48 inches during the preceding 24 hours.

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Central Provinces	76	0·13	0 73

19th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Bombay	29·604	—·251	W	26	215	0·19
Malegaon	·463	—·373	SW	12	152	0·08
Surat	·506	—·321	WSW	?	?	4·65
Rajkot	·547	—·280	WNW	12	128	8 28
Deesa	·545	—·256	N	?	?	...
Ajmere	·530	—·222	NE	7	146	...
Indore	·539	—·265	S	?	?	0·11

The disturbance had intensified considerably during the previous 24 hours, and the depression covered a larger area. The centre had advanced slowly west during the previous 24 hours, and was between Surat and Rajkot, at 10 A.M., and probably passing over the head of the Gulf of Cambay. The cyclonic circulation was marked by the same features as on the previous day. Strong westerly winds were blowing in the southerly quadrant, and light easterly and northerly winds in the northern half of the depression. Heavy rain fell in Guzerat and Cutch, as is shown by the Surat and Rajkot rainfall returns.

20th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Bombay	29·677	—·178	SW	21	174	0·65
Malegaon	·585	—·251	SW	9	114	0·03
Surat	·609	—·218	SW	P	P	3·10
Rajkot	·625	—·202	NNW	15	160	...
Deesa	·628	—·173	NE	P	P	...
Ajmere	·631	—·121	NE	5	104	...
Indore	·608	—·196	NNE	P	P	...

The depression covered the same area as on the 19th, but had partially filled up. It was more widely diffused, the westerly winds upon which its strength depended were decreasing in intensity, and the rainfall diminishing rapidly in amount. The cyclonic circulation in the area of depression was less regular than on the 19th, but still indicated convergence to a centre between Deesa, Surat, and Rajkot.

21st September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Bombay	29·729	—·126	W	15	124	1·23
Malegaon	·656	—·180	WNW	6	76	0·18
Surat	·690	—·137	SW	P	P	0·10
Rajkot	·704	—·123	NW	9	96	...
Deesa	·727	—·074	Calm	P	P	...
Ajmere	666	—·086	NE	3	63	...
Indore	·671	—·133	NNE	P	P	...

The observations of the 21st show that the depression continued to fill up, and was much smaller than hitherto. The air motion was less regular, and the rainfall very small in amount. The depression completely disappeared during the day, and the normal air motion and conditions of pressure were established on the morning of the 22nd.

The more important features of this storm were—

1st.—Its prolonged existence. It began to form on the 12th and 13th, crossed the coast of Orissa on the afternoon of the 14th, marched across the head of the peninsula, and did not fill up and disappear until the evening of the 21st after an existence on land of seven days.

2nd.—Its feeble intensity at sea, and during the first portion of its motion on land. The depression at the centre did not exceed a quarter of an inch at any period previous to the 16th; the winds were very moderate, and the cyclonic circulation feeble. It nevertheless crossed the North Orissa hills apparently intact, although the wind observations at Sambalpur and Cuttack indicate much irregularity in the lower air motion during its progress over these hills.

3rd.—Its intensification when approaching the Bombay coast. The Bombay current fed it with moderate supplies of vapour during its motion across the Central Provinces. The rainfall increased considerably as it passed through Central India, Guzerat, and Cutch. The depression augmented in amount, the lower air circulation intensified, and very heavy rain fell over the southern and western quadrants. During the latter portion of its existence the depression remained almost stationary, and gradually filled up, as the supplies of aqueous vapour diminished in amount.

The following table gives the position of the centre at 10 A.M. on each day of its existence:—

Date.	Position at 10 A.M.		Distance travelled over in previous 24 hours.
	Latitude N.	Longitude E.	
September 13th	19° 0′	89° 45′	.....
„ 14th	19° 15′	87° 0′	.....
„ 15th	20° 30′	85° 0′	150
„ 16th	21° 45′	80° 15′	330
„ 17th	21° 50′	78° 0′	150
„ 18th	22° 30′	74° 0′	„ 265
„ 19th	22° 50′	72° 0′	130
„ 20th	23° 15′	71° 10′	60

(*No. XIII.*)—*Storm of September 18th to the 24th.*—This storm is fully described in Vol. II, Part I, of the Meteorological Memoirs. The following gives a brief summary of its history, and more remarkable features. After the preceding storm crossed the Orissa hills, and passed into the Central Provinces, the rainfall in Bengal, which followed the

re-establishment of southerly winds, began to diminish rapidly in amount from the 15th. An almost complete cessation of the rains obtained over the whole province of Bengal on the 16th and 17th. The winds decreased in force, and were very light and variable on the evening of the 17th. Strong south-west monsoon winds were, on the other hand, blowing at the Andamans and Nicobars, and another advance of humid winds was evidently in progress up the Bay. On the 18th, the conditions were unchanged, except that the area of strong winds and of rainfall had extended northwards up the Bay. Over this area, the weather was more unsettled, and squalls were more frequent and severe, and of longer duration. The existence of the storm was first indicated by the land observations of this day. The barometer was unusually low at Akyab, and moderate indraught from the north was now established over Bengal. There was now a considerable depression in the Bay between the West Burmah coast and the Ganjam and Circars coasts. The centre was in Lat. 18° N. and Long. 89¾° E. Winds were very light and variable at the head of the Bay and in South Bengal, whilst in the area of depression and over the whole of the Bay to the south of it, the weather was stormy, and winds strong with frequent violent squalls. The depression continued to advance northwards, and increased considerably in intensity during the next 24 hours. The centre was at noon of the 20th in Lat. 19° and Long. 89½°. A fresh to a strong gale was blowing at considerable distances from the centre in the easterly and southerly quadrants. The winds in South Bengal were excessively feeble at this time. For example, at Chittagong, the anemometer registered 13 miles for the 24 hours preceding 10 A.M. of the 21st, at Jessore 16 miles, at Patna 25 miles, and at Vizagapatam 8·7 miles. The depression advanced more rapidly during the next 24 hours, and the centre at noon of the 21st was near the coast of the Sunderbunds, about 40 miles to the east of Saugor Island in Lat. 21½° N. and Long. 89° E. The weather was now squally over the north and centre of the Bay, whilst steady south-west winds prevailed over the south of the Bay, and brought up large supplies of vapour, that were discharged as rain at the head of the Bay and in South Bengal. During the day, the cyclonic disturbance continued to increase in intensity, and advanced northwards with a very slight westing. The cyclonic vortex was a short distance to the east of Calcutta on the morning of the 22nd. Very heavy rain was now falling over the whole of South Bengal, and strong southerly winds were blowing across the north coast of the Bay. The centre drifted to the north during the next 24 hours, and at 10 A.M. of the 23rd was, so far as can be determined from the observations, in the Maldah district, nearly midway between Purneah and Berhampore. Strong winds almost approaching in force to a gale were blowing at this time over the whole of South and Central Bengal. The fall of the barometer in front of the advancing storm on the 23rd was much less than on the previous day, and the cyclonic circulation was becoming irregular. The 4 P.M. observations of the 23rd show these indications of the disintegration of the whirl very strongly. Pressure increased rapidly during the night of the 23rd, so that on the morning of the 24th, the disturbance had filled up to a considerable extent, and the residual irregular cyclonic circulation was barely traceable from the observations. It completely disappeared during the day, and on the 25th, weather was fine with light winds, passing clouds, and occasional local showers in Bengal, while skies were clear, or slightly clouded, over the greater part of the Bay.

The path of the storm centre is given by the following data :—

Date.	Position at 10 A.M.		Distance passed over in preceding 24 hours.	Average rate of motion in miles per hour during previous 24 hours.
	Latitude N.	Longitude E.		
September 19th	18° 0′	89° 45′	.....	.....
„ 20th	19° 0′	89° 30′	70	3
„ 21st	21° 20′	88° 55′	165	7
„ 22nd	22° 45′	88° 45′	100	4
„ 23rd	25° 15′	88° 30′	170	7

The more remarkable features of this storm were :—

1st.—The abnormal lightness of the winds in Bengal during the formation and early advance of the disturbance. The following table gives a few examples of this feature :—

	Normal air motion in 24 hours.	18th.	19th.	20th.	21st.	Average of four days from 18th to 21st.	Ratio of amount of wind to average amount expressed as a percentage.
Chittagong	109·3	30·8	29·8	38·7	13·3	28·2	26
Dacca	110·8	17·0	25·0	24·0	54·0	30·0	27
Jessore	81·5	56·5	23·3	18·4	16·0.	28·6	35
Calcutta	111·8	70·0	63·0	73·0	110·0	79·0	71
Berhampore	86·3	56·1	37·4	36·1	44·5	43·5	51
Cuttack	53·4	30·8	22·3	33·7	48·7	33·9	64
Saugor Island	226·2	118·9	131·0	105·1	20·7	93·9	42
Vizagapatam	57·7	57·5	42·7	30·0	8·7	34·7	60

An examination of the above data establishes what is also even more strongly shown by the wind directions, that the air motion was not only very feeble, but was exceedingly irregular. The winds were mere local airs, and their strength and direction depended mainly upon local conditions. The atmosphere in Bengal during this period in which the storm formed and advanced to the head of the Bay was in a state of almost complete stagnation.

2nd.—The unusually large and very generally distributed rainfall which accompanied its march through Bengal. The following gives the average amounts in each division, and also in the North-Western Provinces, the Bombay and Madras Presidencies

on each day from the 22nd to the end of the storm when the rainfall due to the storm commenced in Bengal :—

	No. of stations.	22nd.	23rd.	24th.	Total.
Burdwan	18	5·78	1·04	0·33	7·15
Presidency	29	2·90	1·78	0·78	5·46
Rajshahye	17	1·13	3·45	1·21	5·79
Cooch Behar	6	0·82	4·90	5·35	11·08
Dacca	14	0·76	2·43	1·54	4·73
Chittagong	12	2·03	1·43	1·13	4·59
North-Western Provinces and Oudh	169	0·12	0·17	0·02	0·31
Punjab	32	0·24	...	...	0·24
Bombay	15	0·58	0·15	0·08	0·81
Madras	13	0·18	0·11	0·09	0·38

3rd.—The rainfall was very irregular in its distribution. The seaboard of the Sunderbunds received comparatively small amounts. It increased rapidly northwards from the coast in South-West Bengal, and was distinctly heaviest in that division to the west of the path of the centre, in which a small area comprising the following stations received the largest amounts :—

	22nd.	23rd.	24th.	Total.
Serampore	14·32	0·45	0·88	15·65
Hooghly	8·40	0·85	1·51	10·76
Jehanabad	8·77	1·40	...	10·17
Ghatal	11·08	0·59	0·53	12·20
Barrackpore	14·87	...	1·00	15·87
Baraset	12 32	0·12	0·63	13·07

As it advanced into Central Bengal, the rainfall was most excessive to the east of the line of advance of the vortex in an area including the Mymensingh district. Unusually heavy rain also fell over the Rungpore, Cooch Behar, and Julpigoree districts at the foot of the hills in North Bengal. The following table gives the heaviest rainfalls in these districts :—

District.	Station.	22nd.	23rd.	24th.	Total.
Rungpore	Kurigram	0·41	11·44	2·45	14·30
	Bogdogra	0·31	7·60	4·96	12·87
Julpigoree	Buxa	1·50	3 97	4·64	10·11
	Tetalya	0·73	7·23	2·47	10·43
Cooch Behar	Cooch Behar	2·00	8·85	8·45	19·30
Mymensingh	Mymensingh	1·24	6·20	4·18	11·62
	Atia	0·86	8·05	4·11	13·02

(*No. XIV.*)—*Storm of October 13th to the 16th.*—This was one of a class of storms which occur when the north-east monsoon is blowing in moderate force over the Bay, and which tend to repeat themselves, or to occur as a series of three or four, following each other in rapid succession. In that respect, they resemble the storms called nor'-westers in Bengal, which frequently happen about the same time every evening for three or four days in succession. The reason for the repetition is that the storms are due to a certain combination of atmospheric conditions which they leave almost unaltered.

The first indications of the existence of the storm were presented by the land observations of the 13th. The isobar of 29·85 formed a closed curve enclosing the western portion of the Bay, and the adjacent coast area. The wind directions at the stations round the coast were those which usually obtain during the early portion of the north-east monsoon, and indicated an ill-defined cyclonic circulation of the air over the south and centre of the Bay, due to the recurvature of the south-west monsoon current.

The following gives the observations at the more important stations round the Bay on the morning of the 13th :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Port Blair	29·876	+·051	SSW	10	151
Diamond Island	·905	+·018	SSE	15	228
Akyab	·866	—·048	E	2	74
False Point	·853	—·056	NNE	9	143
Vizagapatam	·815	—·083	N by E	1	57
Masulipatam	·829	—·081	NW	1	?
Madras	·851	—·059	NNE	4	84
Negapatam	·840	—·082	SW	2	39
Colombo	·902	—·050	WNW	7	101

The preceding observations show that the distribution of pressure varied very slightly from the normal. There was a slight defect at Vizagapatam and Masulipatam as compared with the neighbouring stations, which formed the chief indication of the approaching storm. The wind directions prove the recurvature of the south-west current in the south-east of the Bay through south and east to north-east on the Coromandel coast. The south-west humid winds were very strong at Port Blair and Diamond Island, whilst the winds were very feeble on the Coromandel coast—a second indication of the establishment of a whirl in the Bay.

The following were the observations at 10 A.M. of the 14th :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Port Blair	29·946	+·013	SW	10	144
Diamond Island	·963	+·040	S	12	181
Akyab	·947	+·033	SSW	3	122
False Point	·859	—·050	NNE	10	170
Vizagapatam	·744	—·154	NE	3	129
Masulipatam	·756	—·154	NW	1	?
Madras	·868	—·042	N	2	47
Negapatam	·850	—·072	SW	2	42
Colombo	·934	—·018	SW	6	87

The barometer was above its normal height over the east of the Bay. The Vizagapatam and Masulipatam observations indicate that a well-marked depression was now formed not far from the mid-west coast of the Bay, and that it was advancing westwards towards Vizagapatam. No reliance unfortunately can be placed on the Masulipatam barometric observations, as the barometric readings have an unknown error probably amounting to ·03″. The then observer was apparently not thoroughly acquainted with the use of the instrument. The winds to the east of the depression were moderately strong. They were very feeble on the Coromandel coast. The afternoon, or 4 P.M., observations give no additional information. The barometer readings at Vizagapatam were, as at 10 A.M., nearly a sixth of an inch below the mean for that hour of the month.

The observations of the 15th are given below :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Port Blair	29·965	+·038	WSW	8	115
Diamond Island	·946	+·023	ESE	3	48
False Point	·879	—·030	Calm	4	62
Vizagapatam	·803	—·095	SE	5	219
Masulipatam	·745	—·165	NNW	1	?
Secunderabad	·832	—·113	NW	8	244
Bellary	·843	—·078	NNW	7	154
Bangalore	·859	—·077	WSW	5	150
Madras	·841	—·069	W	5	88
Negapatam	·856	—·066	SW	5	110

The depression had not increased in intensity during the previous 24 hours. The centre was apparently crossing the coast at this time to the north of Masulipatam, and Coconada. The depression at the centre was probably not more than two tenths of an inch. The winds were now weaker at the eastern stations, but were considerably

stronger at the Madras stations. They were, however, nowhere violent, the highest average velocity for the previous 24 hours being only 8·3 miles.

The 4 P.M. observations indicate that the centre was travelling slowly north-westwards into the interior.

The observations of the 16th, given below, show irregular cyclonic circulation over a large portion of the south of the peninsula. The disturbance was diffused over a larger area and breaking up.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Negapatam	29·855	—·067	SW	5	127
Madras	·814	—·096	SSW	6	114
Masulipatam	·766	—·144	NNW	?	?
Vizagapatam	·813	—·085	N by E	2	76
Secunderabad	·809	—·136	E	6	162
Bellary	·796	—·125	W	5	107
Bangalore	·839	—·097	WSW	6	178

The observations of the afternoon of the 16th give similar information, and those of the 17th show that the cyclonic disturbance had completely disappeared.

The storm thus formed in the centre of the Bay near the front of the recurved south-west monsoon on the 12th or 13th, and advanced in a general north-westerly direction, and struck the coast between Vizagapatam and Masulipatam on the morning of the 15th. It advanced slowly inland during the next 24 hours, and slightly affected the weather in the Madras Presidency, Mysore, and Hyderabad States, but became more diffused and irregular, and gradually filled up, so that no trace of it was left on the morning of the 17th. The heavy rainfall accompanying it was almost entirely confined to the coast area represented by the stations of Masulipatam and Vizagapatam. As no daily returns of rainfall are published for stations in the Madras Presidency, except the meteorological stations, it is not possible to discuss fully the distribution of rainfall which accompanied the cyclone. The following table of rainfall at the observing stations indicates very roughly its character:—

	13th.	14th.	15th.	16th.	Total.
Vizagapatam	...	0·50	1·00	1·00	2·50
Masulipatam	...	6·66	2·09	...	8·75
Secunderabad	...	...	...	0·43	0·43
Bellary	...	...	...	0·07	0·07
Bangalore	...	...	...	...	...
Madras	0·06	0·06	...	0·45	0·57
Negapatam	...	0·06	...	...	0·06

The rainfall was hence very local, and confined almost entirely to the coast in the immediate neighbourhood of the path of the centre.

(*No. XV.*)—*Storm of October 28th to the 31st.*—This storm was formed under almost identical conditions to those of the previous storm, and moved along an approximately coincident path. The observations of the morning of the 28th, given below, show that the south and centre of the Bay and the Coromandel coast were enclosed by the isobar of 29·85. The pressure differed slightly from its normal distribution, was in defect at Nancowry and Port Blair, and on the Coromandel coast. The winds at Nancowry, Port Blair, and Diamond Island were very strong, and indicated considerable strength in the humid winds of the south-west monsoon current over the south-east of the Bay. The winds on the Coromandel coast were below their average force (except at Madras), and had shifted round to north-north-west and north-west at Madras and Negapatam respectively.

Cyclonic circulation, fed by a strong humid current, was hence established over the south and centre of the Bay. The following are the observations of the 28th, indicating these facts:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·869	—·087	SW	14	223
Port Blair	·845	—·082	SE	16	240
Diamond Island	·912	—·011	E	11	160
Akyab	·916	+·002	NE	1	48
False Point	·922	+·013	ENE	8	132
Vizagapatam	·847	—·051	NNE	2	86
Masulipatam	·831	—·079	NE	1	?
Madras	·816	—·094	NNW	11	224
Negapatam	·838	—·084	NW	2	49

The 4 P.M. observations show no change of wind direction, nor any considerable fall of the barometer. The conditions prevalent over the Bay were, so far as can be determined from the coast observations, unaltered.

The following table gives the observations at the coast stations on the morning of the 29th:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Port Blair	29·880	—·047	SW	7	102
Diamond Island	·914	—·009	E	14	206
Akyab	·902	—·012	NE	1	44
False Point	·910	+·001	NE	9	155
Vizagapatam	·745	—·153	NE	4	171
Masulipatam	·711	—·199	NNW	2	?
Bellary	·854	—·067	NNW	5	109
Bangalore	·829	—·107	W	4	106
Madras	·805	—·105	WNW	10	183
Negapatam	·793	—·129	SW	3	68

The observations show a very considerable fall of the barometer at Vizagapatam and Masulipatam, and a smaller fall over the whole of Southern India. There was now a well-marked whirl near the west coast, between Madras and Vizagapatam. The central depression was evidently small in amount, probably not exceeding a quarter of an inch. The winds were falling off at Port Blair, but were much stronger generally on the west coast of the Bay. They were nowhere violent.

The 4 P.M. observations show a slight further fall of the barometer; but the winds were unchanged, except at Madras, where they had shifted to W. by S. The centre was some little distance to the east of the mouth of the Godavery, which it was approaching.

30th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·856	—·053	SE	12	193
Vizagapatam	·756	—·142	SSE	2	114
Secunderabad	·840	—·105	NE	9	271
Bellary	·791	—·130	NW	5	105
Masulipatam	·690	—·220	NW	2	?
Bangalore	·809	—·127	WNW	5	150
Madras	·778	—·132	SW by W	4	82
Negapatam	·785	—·137	SSW	4	90

The preceding observations show that the centre was crossing the coast between Masulipatam and Vizagapatam, and probably nearest to the latter station. It was hence advancing to the north of the delta of the Godavery. The depression of the barometer was very little more than on the 29th. Hence it was, like the previous storm, a small shallow depression, the barometric height at the centre of which was not more than a quarter of an inch below its normal height in October.

The following are the 4 P.M. observations of the 30th at the same stations:—

Station.	Barometer, 4 P.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 4 P.M.	Velocity in miles per hour for preceding 6 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·745	—·080	ENE	17	280
Vizagapatam	·678	—·134	SSE	?	?
Secunderabad	·721	—·108	NE	2	47
Bellary	·666	—·165	N by W	7	165
Masulipatam	·637	—·185	S	1	?
Bangalore	·722	—·146	W by S	8	222
Madras	·677	—·157	W by N	5	92
Negapatam	·675	—·135	S	5	132

The shift of wind at Masulipatam during the day from north-west to south proves that the central depression was advancing rapidly into the interior. It was, however, changing its character. The depression was smaller in amount, and extended over a larger area than hitherto, the usual indication of the breaking up of a cyclonic disturbance. The 10 A.M. observations of the next day (the 31st) show that it had entirely disappeared, so that the history of the storm ends with the evening of the 30th.

31st October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Vizagapatam	29·821	—·077	SE	0·4	19
Secunderabad	·855	—·090	NE	7	197
Bellary	·802	—·119	NW	8	193
Masulipatam	·775	—·135	NNE	1	?
Bangalore	·853	—·083	SSW	8	231
Madras	·798	—·112	W by N	4	75
Salem	·787	—·173	SW	4	124
Negapatam	·801	—·121	WSW	5	110

There was slight general depression of the barometer at the east coast stations of the Bay, but no distinct cyclonic circulation.

This cyclonic disturbance was evidently a repetition of the previous storm in all its important features. It formed under similar circumstances in the same part of the Bay, advanced along the same path, crossed the same part of the west coast, and broke up shortly afterwards, after an existence of the same duration, *viz.*, about four days. The rainfall which occurred during the storm at the meteorological stations in Southern India is given in the following table, which shows that heavy rainfall was restricted to the coast districts represented by Vizagapatam and Masulipatam. The former received a total of 9·1 inches and the latter of 9·42 inches during the storm—amounts larger than had obtained during the preceding storm. The local character of the rainfall is clearly shown by the following return:—

	28th.	29th.	30th.	31st.	Total.
Secunderabad	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*
Salem	*Nil.*	*Nil.*	0·60	*Nil.*	0·60
Vizagapatam	1·20	5·90	1·50	0·50	9·10
Bellary	*Nil.*	*Nil.*	0·43	0·11	0·54
Masulipatam	0·12	5·75	2·01	1·54	9·42
Madras	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*
Bangalore	*Nil.*	*Nil.*	0·03	0·09	0·12
Negapatam	0·65	*Nil.*	0·05	*Nil.*	0·70

(*No. XVI.*)—*Storm of November 4th to the 6th.*—This was a small storm and of little importance. It, however, formed under the same conditions as the previous two

storms, and pursued the same path. The observations of the 3rd give very slight and doubtful indications of its generation. The following observations of the 4th show that there was on that day a well-defined barometric depression over the western portion of the Bay and the Coromandel coast:—

4th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·861	—·099	SW	9	174
Port Blair	·814	—·144	SSE	6	84
Diamond Island	·834	—·139	SE	23	274
Akyab	·840	—·158	E	2	96
False Point	·799	—·252	NE	13	198
Vizagapatam	·717	—·304	N	1	56
Masulipatam	·700	—·313	NE	1	?
Madras	·741	—·250	W by N	5	75
Negapatam	·746	—·221	SW	2	27
Colombo	·837	—·112	WSW	10	192

The barometer was lowest at Vizagapatam and Masulipatam. The winds indicate cyclonic circulation of moderate intensity. The south-west winds at Colombo and Nancowry were considerably above their normal strength, and establish that a strong humid current was feeding the atmospheric whirl. The winds on the Coromandel coast were very light. The 4 P.M. observations of the same stations indicate that the conditions were unchanged at that hour.

The morning observations of the 5th show a considerable fall of the barometer at Vizagapatam and Masulipatam, and a shift of wind at the former station from north to east, which indicated that the centre was approaching the coast between these two stations. The winds were light on the Coromandel coast, and were stronger than the normal on the Orissa coast, but were nowhere violent.

The following gives the 10 A.M. observations of the 5th:—

Station.	Barometer 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·902	—·058	SW	5	85
Port Blair	·869	+·011	SE	7	90
Diamond Island	·872	—·101	SE	10	124
Akyab	·857	—·144	E	4	164
False Point	·785	—·266	Calm	12	183
Vizagapatam	·548	—·476	E	7	264
Masulipatam	·578	—·435	NE by N	2	?
Madras	·750	—·243	WSW	7	97
Negapatam	·758	—·209	SW	3	59

The 4 P.M. observations when charted establish that the centre was crossing the coast to the north of the mouth of the Godavery. The winds, as hitherto, were comparatively feeble. The observations are given in the following table:—

Station.	Barometer, 4 P.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 4 P.M.	Velocity in miles per hour for preceding 6 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·826	—·038	SW	?	?
Port Blair	·781	—·077	WSW	10	140
Diamond Island	·784	—·073	SE	8	101
Akyab	·706	—·100	SSE	4	182
False Point	·705	—·220	SE	8	127
Vizagapatam	·522	—·381	SE	?	?
Masulipatam	·529	—·386	NE	3	?
Madras	·634	—·246	W by S	6	88
Negapatam	·673	—·190	SSW	5	96

The following are 10 A.M. observations taken in the area of disturbance on the 6th:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Port Blair	29·893	—·065	SW	5	71
Diamond Island	·922	—·045	E	6	76
Vizagapatam	·772	—·249	W	9	348
Masulipatam	·753	—·260	NNE	3	?
Bangalore	·845	—·141	WSW	5	153
Bellary	·838	—·158	W	7	225
Madras	·817	—·174	WSW	6	90
Sambalpur	·672	—·343	E	?	?
Raipur	·714	—·345	NE	10	333
Chanda	·765	—·312	N	6	300

The observations of the 6th show the presence of a moderate and extensive depression to the north of Vizagapatam, and indicated chiefly by the wind directions at Vizagapatam, False Point, Sambalpur, Chanda, and the neighbouring stations. The storm was hence breaking up under the action of the hills to the west of Vizagapatam. It disappeared completely before the morning of the 7th.

The rainfall which accompanied this storm was apparently much smaller than that of either the two previous storms. The following amounts were registered at the Madras meteorological stations during the storm :—

Station.	4th.	5th.	6th.	Total.
Vizagapatam	0·10	2·00	0·70	2·80
Masulipatam	0·29	0·52	*Nil.*	0·81
Bangalore	0·04	*Nil.*	*Nil.*	0·04
Bellary	0·26	*Nil.*	*Nil.*	0·26
Madras	0·01	0·01	*Nil.*	0·02
Negapatam	0·47	*Nil.*	*Nil.*	0·47

(*No. XVII.*)—*Storm of December 5th to the 8th.*—This storm was apparently generated under similar conditions to those of the three previous. It advanced in the same general direction, struck the same part of the coast, and broke up very shortly afterwards. It lasted for a slightly longer period than the preceding, but was chiefly remarkable for the excessive rainfall it gave to Vizagapatam and the adjacent districts.

The following observations of the 5th gave the first clear indications of its existence —

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·892	—·075	SW	4	63
Port Blair	·939	—·047	E	15	213
Diamond Island	·990	—·024	E	17	243
False Point	·965	—·148	NE	7	106
Vizagapatam	·856	—·231	E	3	136
Masulipatam	·802	—·270	NE	2	?
Madras	·812	—·236	NW	13	171
Negapatam	·810	—·201	W	2	29

The observations establish that there was a depression over the south-west and centre of the Bay and the Coromandel coast, and that the winds were circulating cyclonically with respect to the depression.

6th December.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·937	—·030	SE	3	37
Port Blair	·916	—·070	E	11	157
Diamond Island	·925	—·089	ENE	13	186
False Point	·931	—·182	NE	11	167
Vizagapatam	·780	—·307	NE	4	182
Masulipatam	·692	—·380	NE	2	?
Madras	·810	—·238	WNW	9	118
Colombo	·872	—·099	WSW	9	129

The barometer had fallen considerably during the previous 24 hours. The wind directions at Port Blair and Nancowry were abnormal, and evidently did not form part of the cyclonic circulation. The cyclone was hence probably of small extent, although it was of considerable intensity, the depression almost certainly exceeding half an inch at the centre. The winds were stronger than in the previous storms, but were nowhere excessive. The continued feebleness of the winds at Nancowry is striking.

The 4 P.M. observations showed a slight further fall of the barometer at Masulipatam, but no change in the direction of the winds.

7th December.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·930	—·037	ENE	3	37
Port Blair	·906	—·080	E	7	96
Diamond Island	·917	—·097	NE	5	69
False Point	·900	—·213	ENE	11	167
Vizagapatam	·683	—·404	ESE	11	496
Masulipatam	·694	—·378	NE	3	?
Madras	·825	—·223	SW	7	88
Negapatam	·831	—·180	SW	3	42
Colombo	·864	—·090	E	7	100

These observations, and more especially the shift of wind at Vizagapatam, plainly indicated that the centre was near the coast, and to the south of that station. 10·3 inches of rain had fallen at Vizagapatam during the previous 24 hours, whilst none fell at Masulipatam. The winds were unusually strong at Vizagapatam, but were very feeble from Masulipatam southwards. The 4 P.M. observations show that the centre was then crossing the coast, a little to the south of Vizagapatam, and that the depression was already commencing to fill up.

8th December.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·941	—·026	ENE	3	43
Port Blair	·886	—·100	E	4	60
Diamond Island	·979	—·035	NE	4	54
False Point	·950	—·163	NE	9	141
Vizagapatam	·833	—·254	SSE	10	473
Secunderabad	·903	—·202	NE	8	277
Bellary	·905	—·151	NW	6	203
Masulipatam	·821	—·251	NE(?)	1	?
Madras	·870	—·178	SSW	6	79

No change of importance had occurred in the wind directions during the previous 24 hours, except at Vizagapatam, where the wind had shifted to south-south-east. The observations when charted indicate the presence of a depression to the west of Vizagapatam, the centre of which was probably not more than 50 miles to the west of that station. It had, in fact, been nearly stationary during the previous day, and had partly filled up, so that the central depression was probably not more than three-tenths of an inch. Very heavy rain had continued to fall at Vizagapatam, whilst none fell at Masulipatam or in the interior of the Madras Presidency.

The following are the 4 P.M. observations of the same day:—

Station.	Barometer, 4 P.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 4 P.M.	Velocity in miles per hour for preceding 6 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nancowry	29·850	—·023	NE	?	?
Port Blair	·821	—·065	ENE	4	57
Diamond Island	·837	—·069	NW	5	71
False Point	·875	—·110	NE	12	176
Vizagapatam	·764	—·192	SW	?	?
Secunderabad	·784	—·161	NE	1	43
Bellary	·763	—·159	SSE	4	142
Masulipatam	·768	—·202	NE	1	?
Madras	·755	—·181	SE	5	66

The shift of wind from south-south-east to south-west at Vizagapatam apparently indicated a continued slow westward movement of the storm centre. The depression was, however, now rapidly filling up, as is more completely shown by the following observations of the 9th:—

9th December.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·983	—·130	ENE	8	126
Vizagapatam	·930	—·157	S	1	46
Secunderabad	·964	—·141	NW	4	133
Bellary	·934	—·122	ENE	4	129
Bangalore	·906	—·136	E	1	29
Belgaum	·970	—·076	E	1	24
Madras	·950	—·098	S	2	26

The observations of the 9th establish that the depression had nearly filled up, and that the cyclonic circulation was no longer in existence. The winds at the majority of the

stations in Southern India at 10 A.M., were remarkably light, and barely 25 per cent. of their ordinary force.

The following rainfall returns clearly indicate that the depression was extremely small, and that the disturbance partook more of the nature of a large waterspout than of an ordinary cyclonic disturbance:—

Station.	5th.	6th.	7th.	8th.	9th.	Total.
Vizagapatam	0·70	7·60	10·30	4·90	2·00	25·50
Masulipatam	...	0·32	...	...	...	0·32
Madras	...	...	...	...	0·31	0·31
Negapatam	...	...	...	...	...	*Nil.*
Bangalore	...	...	...	...	...	*Nil.*
Bellary	...	...	...	...	...	*Nil.*
Secunderabad	...	...	...	...	...	*Nil.*

Vizagapatam received the very large amount of 25·5 inches during the storm, whilst none of the nearest reporting stations received more than a third of an inch. The monthly rainfall return of the Madras Presidency for October also appears to indicate that the rainfall was very local, and confined to a small area in the neighbourhood of Vizagapatam, extending 20 miles along the coast in each direction, and not more than 40 miles into the interior.

An inspection of the storm chart for 1878 indicates that the following were the chief peculiarities of storm occurrence of that year:—

1st.—There was a very unusual and entire absence of storms during the pre-monsoon and early monsoon months of May and June. The first storm of the year did not occur until nearly the end of July.

2nd.—Although there were several considerable depressions and small cyclonic storms generated in the Bay during the year, only one passed into Bengal, and none into Arakan or Burmah.

3rd.—Three of the storms crossed the Orissa coast, but further to the south than usual. Two of these storms advanced across Pooree into the interior.

4th.—The tendency to the formation of the storms further to the south than usual was shown strongly in the first storm of the season (that of the last ten days of July) which was initiated to the south of latitude 18° N., and probably in the latitude of Diamond Island.

5th.—The storms of the south-west monsoon months proper showed a strong tendency to march across the head of the Peninsula to Western India. Four storms were formed during this period. One marched westward as far as the Sind Frontier, a second broke up near the west coast in Cutch. The remaining two advanced into the Central Provinces and Central India before disintegration.

6th.—There was a remarkable succession of four storms, which were formed during the months of October, November, and December, and advanced to the same part of the coast between Masulipatam and Vizagapatam. They

were all similar in character, of unusually small extent, and gave excessive rain to the coast districts, represented by Masulipatam and Vizagapatam.

7th.—The Coromandel coast, south of Masulipatam was free from cyclonic storms during the whole year.

1879.

The year 1879 was not marked by any large local abnormal variations of pressure. Pressure during the pre-monsoon period was considerably below the average, more especially in May. This accompanied excessive temperature during the months of January, February, April, and May over nearly the whole of India. There was also slight excess in Eastern India in March. May was a very hot month. The mean temperature of Behar was 4° above the average for that month, of the North-West Provinces and Oudh 5°, and of the Punjab 3°. As a further consequence, the air was unusually dry in Upper India, more especially in April and May. April was an exceptionally dry month.

The dry hot winds of Northern India and the sea breezes of Bengal were during the pre-monsoon months of unusual strength and steadiness.

The local abnormal barometric variations at the commencement of the south-west monsoon were positive to the south of a line running through Roorkee, Lucknow, Allahabad, Cuttack, and Akyab, and were negative to the north of it. The positive abnormal variations were nowhere large, except perhaps in Western India.

The rain set in over Bengal on the 14th of June, and extended almost immediately over the whole province. In the Bombay Presidency, they were unusually late, not commencing at Bombay until the 24th June. The Bay of Bengal current blew in full strength in June and July. The Bombay branch was very weak in June, and still more so in July, and rainfall was very deficient over a large part of Bombay, the Central Provinces, Rajputana, and Central India.

Both currents blew fairly strongly in August, and the rainfall of the month was on the whole slightly above the average. In September, it was generally somewhat below the average, but excessive local rainfalls occurred in connection with cyclonic vortices that passed from the Bay over Northern India.

The south-west monsoon rainfall was below the average in the Punjab, Western Rajputana, the Gangetic Delta, and Western Bengal, and above it elsewhere, more especially the North-West Provinces and Behar. Also the rainfall in each of the two great branches of the south-west monsoon current was excessive in those provinces which lay to their eastward, and which they reached by south or south-west winds, and were weak to their westward, or in these tracts they reached by a partial recurvature.

Amongst the minor features of the distribution of pressure the following were important:—

1st.—Pressure, relatively to the normal distribution was most deficient in Arakan, Pegu, Central and North Bengal, and hence there was a marked tendency to the formation of local areas of low pressure and the occurrence of heavy rainfall in these districts.

2nd.—The line of junction of the two monsoon branches which is usually defined by the belt of low pressure, stretching from the Orissa coast to Upper Sind or the South-West Punjab was absent in July. It ran from Cuttack through Sambalpur to Sutna in August and September, and, as usual, disappeared

before the beginning of October. This line was hence absent in July, and was somewhat further south than its normal position in August and September.

The north-east monsoon rains set in over the Madras coast districts on the 19th of October, and general rain, more or less heavy, fell daily in the Carnatic. The rainfall of November was slightly below the average, except in certain districts which received unusually heavy rain from a storm which passed up from the Bay. Heavy rain also fell at intervals on the South Madras coast during the month of December.

(*No. XVIII.*)—*Storm of May 19th to the 24th.*—This storm was very similar in its generation to that of May 1877. It was formed to the west of the Andamans during the first rush of the monsoon current into the Bay, and advanced in a westerly direction to the Madras coast, which it struck very near Madras, and probably a few miles to the north of it. Unlike the corresponding storm of 1877, it broke up almost immediately after reaching land.

The observations of the 19th first indicated the formation and approach of this storm. The barometer had fallen rapidly on the 17th and 18th, and was a tenth of an inch below the May mean at Madras on the morning of the 19th. The winds at the Coromandel coast stations shifted on the afternoon of the 18th, when they began to indicate indraught in the western quadrant of a cyclonic circulation.

19th May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·816	—·088	SW	11	170	0·75
Port Blair	·780	—·085	SSE	6	77	0·53
Diamond Island	·811	—·046	SSE	7	111	0·22
Akyab	·756	—·066	SE	2	59	0·02
False Point	·720	—·041	SSE	11	92	...
Saugor Island	·720	—·027	S	17	117	...
Vizagapatam	·689	—·082	E	2	51	...
Masulipatam	·676	—·107	NW	?	?	0·03
Madras	·700	—·101	NW	8	84	...
Negapatam	·783	—·042	SW	10	130	1·07
Colombo	·799	—·096	WSW	20	253	0·07

The observations of this day show that the barometer was considerably below the normal, and that it was lowest on the west coast between Madras and Vizagapatam. The area of most deficient pressure extended across the Bay to Port Blair and Nancowry. The Colombo and Nancowry observations prove that very strong south-west winds were blowing on the Ceylon coast and at the Nicobars, and hence probably over the south of the Bay. These strong winds had, however, not yet advanced to Port Blair. They were giving moderate showers in Ceylon, and the Nicobars and Andamans.

20th May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·850	—·054	WSW	8	123	2·02
Port Blair	·790	—·075	SE	5	64	0·45
Diamond Island	·806	—·051	ESE	13	206	0·04
Akyab	·792	—·030	E	3	88	...
False Point	·733	—·028	ESE	4	34	...
Saugor Island	·738	—·009	SSE	11	76	...
Vizagapatam	·666	—·105	NE	5	128	1·70
Masulipatam	·608	—·175	NW	?	?	1·80
Madras	·570	—·231	WSW	11	116	0·25
Negapatam	·669	—·156	SW	5	65	0·04
Colombo	·790	—·105	WSW	20	253	...

A considerable fall of the barometer had taken place during the previous 24 hours at Madras and Masulipatam, indicating that the depression was in the immediate neighbourhood of the coast. The centre was to the east of Madras. The winds were generally weak on the west and north coasts of the Bay. They were slightly above average strength over the coast area between Madras and Vizagapatam, in consequence of the indraught. Strong south-west humid winds continued in the south of the Bay, as is evidenced by the Colombo and Nancowry observations. The centre of the depression, so far as it can be inferred from the wind directions at the coast stations, was probably in latitude 13°15′ north and longitude 81°15′ east.

21st May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·880	+ 015	WSW	7	90	0·20
Diamond Island	·875	+·018	SE	13	206	...
False Point	·808	+·047	ESE	5	42	0·01
Saugor Island	·832	+·085	S	9	62	0·07
Vizagapatam	·714	—·057	E	6	154	7·20
Masulipatam	·571	—·212	NE	?	?	3·59
Bellary	·656	—·142	NW	10	119	0·91
Bangalore	·632	—·196	W	9	173	0·72
Madras	·414	—·387	S	25	263	4·16
Negapatam	·598	—·227	SW	10	130	0·02
Colombo	·808	—·087	WSW	23	290	0·30

The centre of the depression crossed the coast on the morning of the 21st, and was a few miles to the north-west of Madras at 10 A.M. The barometric depression at Madras was nearly four-tenths of an inch, and slightly exceeded half an inch at the centre. The winds were by no means violent at Madras, but they brought up an unusually heavy sea, which inflicted much damage on the pier.

Heavy rain fell over a large portion of the coast districts of the Madras Presidency, but it was distinctly heaviest over the Northern Circars at a considerable distance to the north of the storm centre, and, in fact, almost beyond the limits of the storm area.

The rainfall of the 21st in the Madras Presidency was partly due to the cyclonic disturbance, the centre of which advanced westwards into the interior during the day, and partly to the advance of south-west moist winds along the Malabar Coast. The character of the rainfall due to the two actions is shown by the following :—

Stations in eastern districts of Southern India.	Rainfall during 24 hours previous to 6 P.M.	Stations in western districts of Southern India.	Rainfall during 24 hours previous to 6 P.M.
Vizagapatam	1·60	Cochin	1·55
Masulipatam	3·04	Palghat	3·01
Guntoor	1·75	Calicut	5·50
Bellary	2·19	Tellicherry	4·38
Gooty	1·30	Cannanore	1·80
Cuddapah	2·25	South Canara	7·30
Vellore	2·40	Bangalore	2·28
Arcot	1·30	Mysore	2·60
Palmanar	1·87	Mercara	3·62
Madras	1·04		

22nd May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Vizagapatam	29·770	—·001	E	4	103	1·20
Masulipatam	·696	—·087	ENE	P	P	2·13
Madras	·679	—·122	S	15	158	0·01
Negapatam	·701	—·124	SW	7	91	...
Bellary	·609	—·189	E	12	143	1·48
Bangalore	·602	—·226	SSE	14	269	1·96
Madura	·709	—·130	SW	7	184	...
Cochin	·748	—·149	W	4	R	2·02

The observations of the 22nd show that the depression had partially filled up, and was no longer important. The wind directions at the stations in the Deccan and Mysore indicate irregular cyclonic motion of the air, but it was evidently the residual effect of the considerable circulation of the 21st, which had been disintegrated in its march over the broken ground of the Southern Deccan and Mysore. The winds shifted to west and south-west during the afternoon over the whole of Southern India, so that

even this trace of the previous cyclonic circulation completely vanished before the morning of the 23rd. It may be added that this first burst of the monsoon hardly affected the weather in Burma and Bengal, the latter of which areas received local showers during thunderstorms.

The south-west monsoon continued to advance along the Malabar Coast and gave heavy rain during the day. The following are the amounts recorded at several of the Malabar coast stations at 6 P.M. of the 22nd :—

	Inches.		Inches.
Tinnevelly	1·40	Tellicherry	1·80
Cochin	1·51	Calicut	1·35
South Canara	1·75	Manantoddy	2·45
Cannanore	3·40		

The only rainfalls exceeding one inch in the eastern districts of the Madras Presidency were —

	Inches.		Inches.
Vizagapatam	1·40	Coconada	1·89
Bimlipatam	1·00	Masulipatam	2·40

(*No. XIX.*) — *Storm of the 29th May to the 2nd June.*—This was a very small storm. Its formation is interesting as illustrative of the usual mode of the generation of cyclonic circulations at the commencement of the south-west monsoon. Recent experience shows that in such cases strong southerly winds commence at the entrance to the Bay. The area of southerly winds extends northwards, and is characterized by squally weather and much rain. These features are most marked over the northern portion of the extending area of strong southerly winds. As it advances over the centre and the north of the Bay, the eddying motion in front increases in amount and intensity, and the rainfall is more concentrated and severe. Frequently the eddying motion also becomes more regular, and accumulates, and gives rise to a cyclonic disturbance which advances slowly landwards; after which strong monsoon humid winds are established for a period in Bengal, and cause heavy and general rain.

The history of this small storm commences with the 28th of May, when the observations show that there was an advance of strong southerly winds up the Bay.

28th May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·854	—·011	SW	8	100	1·65
Diamond Island	·862	+·005	WSW	13	206	1·38
Akyab	·747	—·075	SSE	9	265	1·11
Chittagong	·734	—·077	ESE	7	108	...
Dacca	·726	—·047	S	6	95	1·38
Saugor Island	·649	—·098	S	10	69	...
False Point	·629	—·132	SSW	7	59	0·26

The preceding observations show that very strong winds were blowing at Diamond Island and Akyab, and were giving moderately heavy rain. These winds were evidently

due to the advance of strong south-westerly winds up the Bay which had reached the latitude of Akyab, but were as yet to the south of the latitude of Chittagong. The ordinary local sea-winds of the month of May still obtained in South Bengal, but they were much weaker than the normal. This was, of course, due to the indraught from the north to the area of advancing rainfall and south-west winds. Moderate showers occurred in Bengal and Orissa during the day. They accompanied thunderstorms, and were due to the local sea-winds. The following table gives average rainfall results for the 24 hours preceding 6 P.M. :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	14	0·94	2·80
East Bengal	24	0·53	2·03
South-West Bengal	46	0·28	1·02
Orissa	15	0·41	1·15

29th May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·828	—·029	WSW	10	159	1·14
Akyab	·758	—·064	SSW	4	118	1·31
Chittagong	·707	—·104	SE	7	108	...
Dacca	·660	—·113	SE	6	95	...
Saugor Island	·574	—·173	ESE	9	62	0·31
False Point	·572	—·189	NW	8	63	0·41

The observations of the 29th show that the barometer was falling rapidly. The winds had weakened at the east coast stations of the Bay. They had shifted round to east-south-east at Saugor Island, and north-west at False Point, thus indicating that a cyclonic circulation was established in the north-west angle of the Bay. The indraught to it diminished the rainfall in South Bengal. Moderately heavy rain continued to be received in Burma and Arakan.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	14	0·80	2·08
East Bengal	24	0·09	0·60
South-West Bengal	46	0·17	1·40
Orissa	15	0·57	1·76

The probable position of the centre of the disturbance at 10 A.M. of the 29th, as indicated by the land observations, was latitude 20° 50′ North and longitude 87° 50′ East.

30th May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·818	—·039	SW	11	175	1·00
Akyab	·708	—·114	SSE	5	147	0·62
Chittagong	·674	—·137	E	7	108	...
Dacca	·655	—·118	SE	7	111	...
Saugor Island	·540	—·207	ESE	12	83	0·06
False Point	·507	—·254	S	7	59	0·32
Cuttack	·458	—·283	W	3	60	6·87
Sambalpur	·472	—·211	N	2	67	0·46
Hazaribagh	·545	—·145	ENE	12	135	...

The observations show a further considerable fall of the barometer. The depression had passed across the Orissa coast during the previous 24 hours. The centre at 10 A.M. was in latitude 20° 50′ North and longitude 86° 20′ East, or to the north of Cuttack, and was passing across the North Orissa Hills. Strong south-west winds, giving moderately heavy rain, continued on the Burma Coast.

The character of the rainfall is indicated by the following statement:—

	Number of stations.	Average rainfall during the previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	1·04	3·30
South-West Bengal	46	0·16	0·95
East Bengal	24	0·15	1·16
Orissa	15	1·07	5·63

31st May.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·891	+·034	SW	14	222	5·37
Akyab	·877	+·055	S	15	441	2·96
Chittagong	·736	—·075	ESE	9	138	...
Dacca	·660	—·113	S	9	143	0·06
Saugor Island	·537	—·210	SSE	15	103	0 81

31st May—continued.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
False Point	·484	—·277	SSE	6	50	1·40
Cuttack	·452	—·289	WSW	1	20	0·80
Sambalpur	·454	—·229	NW	1	33	0.25
Raipur	·456	—·233	SE	9	129	2 69
Hazaribagh	·501	—·189	E	15	167	0·21
Allahabad	·534	—·152	NE	8	267	...
Jubbulpur	·446	—·262	NE	5	180	0·02
Seoni	·469	—·226	NW	5	125	0·75
Nagpur	·514	—·188	W	8	133	0·67

The observations of the 31st prove that the cyclonic circulation had crossed the North Orissa Hills and was in the Central Provinces, the centre being to the east of Sambalpur, in latitude 21° 45′ North, longitude 84° 45′ East. The depression covered a larger area than on the 30th and the wind directions at one or two of the neighbouring stations (more especially Raipur) show that the circulation was somewhat irregular. Moderately strong monsoon winds were blowing on the west coast of India, and giving heavy rain as far north as Ratnagiri. Another burst of monsoon winds was advancing up the Bay, and was already producing very heavy rain in Burma and Arakan. Diamond Island received 5·37 inches during the previous 24 hours, Rangoon 2·79 inches, Moulmein 2·65 inches, Bassein 4·32 inches, and Akyab 2·96 inches. The following table gives average rainfall data for the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	2·32	6·06
South-West Bengal	46	0·44	2·74
Orissa	15	0·26	0·88
Central Provinces	76	0·55	5·30

1st June.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·867	+·063	SSW	12	140	1·25
Akyab	·764	+·028	SSE	4	103	2·57
Chittagong	·708	+·015	SSW	11	157	1·47
Dacca	·610	—·033	SE	10	133	1·00
Saugor Island	·524	—·083	SSW	21	151	0·71
False Point	·530	—·102	SW	15	143	0·05
Sambalpur	·489	—·092	SE	1	33	0·19
Jubbulpur	·430	—·183	E	7	123	0·42
Seoni	·469	—·146	NW	7	125	8·65
Nagpur	·499	—·139	S	8	114	7·40
Raipur	·516	—·087	W	11	141	1·68

The observations of the 1st June show that the Bombay monsoon current, which was established over the coast to about latitude 18° North, now began to feed into the cyclonic circulation. This indraught had given very heavy rain during the preceding 24 hours to the greater part of the Central Provinces at the expense of the Bombay coast districts. The centre of the cyclonic circulation was apparently between Seoni and Jubbulpur in latitude 23° North and longitude 80° East. Moderately strong westerly winds were blowing in the southern quadrant, and the rainfall was very heavy during the day in portions of the Nagpur and Nerbudda divisions of the Central Provinces, as is shown by the following table :—

Division.	District.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Nagpur	Nagpur	7·12	10·30
	Bhandara	0·53	0·80
	Chanda	1·50	2·45
	Wardha	0·45	1·20
	Balaghat	1·29	2·25
Nerbudda	Betul	3·50	6·20
	Chhindwara	5·25	6·50
	Hoshangabad	0·44	1·24
	Narsinghpur	0·82	2·35

The following table gives similar rainfall averages to those of the preceding days :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	14	1·12	4·26
South-West Bengal	46	1·18	4·30
East Bengal	24	1·50	3·36
Orissa	15	0·03	0·19

2nd June.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Chittagong	29·584	—·109	ESE	8	114	2·98
Dacca	·534	—·109	S	11	147	2·78
Jessore	·508	—·133	SSW	7	140	0·17
Berhampore	·476	—·142	SSW	6	110	1·84
Calcutta	·514	—·093	SW	11	172	...
Burdwan	·493	—·115	SSW	7	138	0·18
Saugor Island	·537	—·070	SW	28	201	...
Nagpur	·623	—·015	W	9	129	3·07
Jubbulpur	·548	—·065	W	4	70	3·04
Seoni	·573	—·042	SW	5	89	1·10
Raipur	·618	+·015	W	11	141	0·20

The observations of the 2nd show that the cyclonic vortex in the Central Provinces had disappeared during the previous 24 hours, and that westerly and south-westerly winds were established over the whole of the Central Provinces, Chutia Nagpur, Central India, and Rajputana. Whether this was due to a failure in the supply of aqueous vapour from the Bombay coast, or to the advance of a strong humid current across the Bengal coast is not quite certain, but it is very probable the former was the reason. Moderate rain had fallen during the preceding 24 hours in parts of the Central Provinces, the distribution of which is shown in the accompanying table:—

Division.	District.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Nagpur	Nagpur	1·69	3·45
	Bhandara	0·10	0·30
	Chanda	0·43	2·00
	Wardha	.....	.....
	Balaghat	0·23	0·70
Jubbulpur	Jubbulpur	2·03	3·00
	Saugor	.....	.....
	Damoh	0·61	1·00
	Seoni	2·82	5·30
	Mandla	.....	.....
Nerbudda	Betul	0 49	1·00
	Chhindwara	0·04	0·10
	Hoshangabad	0·45	1·70
	Narsinghpur	0·44	1·32
Chhattisgarh	Nimar	.....	.....
	Raipur	0·10	0·20
	Sambalpur	0·04	0·07
	Bilaspur	0·06	0·15

The contrast between the strength of the two currents, as estimated by the amount of the rainfall, is indicated by the following average returns for the next three days:—

	Average rainfall of 2nd.	Average rainfall of 3rd.	Average rainfall of 4th.	Total average rainfall of three days, 2nd to 4th.
South-West Bengal	0·43	0·73	0·16	1·32
East Bengal	1·73	1·88	0·35	3·96
North Bengal	1·50	1·51	0·27	3·28
Orissa	0·01	0·06	0·03	0·10
Central Provinces	0·51	0·02	.....	0·53

It is hence almost certain that the disintegration of the storm in the Central Provinces, after crossing the Orissa Hills, and its failure to advance further westwards was intimately related to the weakness of the Bombay current, and the small supplies of vapour brought up by it at the time.

(*No. XX.*)—*Storm of 8th August to the 13th.*—This cyclone appears to have formed on the 8th August in the immediate neighbourhood of the coast of the north-west angle of the Bay. The following gives the 10 A.M. observations of that day at the nearest stations:—

8th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·640	—·114	E	8	75
False Point	·664	—·021	WSW	9	99
Calcutta	·632	—·030	S	3	58

The depression was not large, and the air motion was below the average. The influence of the cyclonic circulation did not extend as far as Calcutta at this time, as southerly winds were blowing there, and over the whole of Central and North Bengal. Moderate rain was falling in Orissa and South-West Bengal. The following gives the average amounts in these districts:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	46	0·61	3·09
Orissa	14	1·17	4·00

9th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·586	—·099	W	12	132
Saugor Island	·535	—·219	SSW	18	170
Calcutta	·565	—·097	ESE	5	160
Burdwan	·557	—·109	E	3	79
Hazaribagh	·564	—·093	NE	6	80

The cyclonic vortex had intensified considerably during the preceding 24 hours. The barometric depression at Saugor Island, the nearest observing station, had increased to two-tenths of an inch. The centre probably crossed the Balasore coast during the morning, at about 8 A.M. The air motion at Saugor Island and False Point was considerably above the normal, but was by no means excessive. The rainfall was less in amount than on the 8th, although southerly winds had again set in over Southern Bengal.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	46	0·29	1·35
Chutia Nagpur	9	0·36	1·12
Orissa	14	0·79	1·40

10th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Cuttack	29·537	—·145	SW	9	290
Saugor Island	·519	—·235	SW	30	280
Calcutta	·510	—·152	S	9	175
Burdwan	·494	—·172	ESE	6	158
Hazaribagh	·507	—·150	NNE	7	94
Sambalpur	·420	—·229	NW	9	138

The vortex was near, and to the north-east of, Sambalpur on the morning of the 10th. It had intensified considerably during the preceding 24 hours. The barometric depression at Sambalpur was nearly a quarter of an inch, and ranged from ·15″ to ·25″ over Orissa, South-West Bengal, Chutia Nagpur, and the north-eastern districts of the Central Provinces. The air motion had increased considerably over the eastern half of the cyclonic area, and was from two or three times its average amount. Strong winds were blowing in South-West Bengal and Orissa. The rainfall was also much heavier, more especially in Orissa, over which an average of two inches fell during the 24 hours preceding 6 P.M.—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
South-West Bengal	46	0·40	1·60
Orissa	14	2·00	7·57
Chutia Nagpur	9	0·54	1·80
South Behar	18	0·39	2·12
Central Provinces	20	0·59	3·20

11th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Cuttack	29·575	—·107	SSW	8	290
Burdwan	·567	—·099	SE	7	184
Hazaribagh	·467	—·190	ESE	7	94
Patna	·527	—·122	E	3	95
Sutna	·531	—·115	NW	8	104
Jubbulpur	·604	—·086	W	8	167
Raipur	·618	—·056	W	10	154

The depression had advanced to the north-north-west during the preceding 24 hours, and the centre was in Chutia Nagpur to the west-south-west of Hazaribagh, where the observed barometric depression was greatest and amounted to ·19″. The air motion was considerably above the average in Orissa and South-West Bengal, but was slightly below it in Behar and Chutia Nagpur. Moderately heavy rain continued to fall in connection with the disturbance, and was largest in amount at this time in Chutia Nagpur and the Central Provinces. The following table gives average rainfall data of the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·29	1·00
Chutia Nagpur	9	1·01	2·75
South Behar	18	0·36	1·00
Central Provinces	20	1·08	3·10

12th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Sutna	29·406	—·240	WSW	10	130
Allahabad	·491	—·143	SE	8	229
Lucknow	530	—·102	E	4	138
Jhansi	·467	—·161	NE	7	200
Nowgong	·472	—·173	N	5	143

The cyclonic vortex had advanced in an approximately west-north-westerly course during the preceding 24 hours, and was in Bundelkhand to the east of Jhansi and Nowgong, and between the latter station and Sutna. The depression was larger in amount than it was on the 10th and 11th, and the disturbance was evidently intensifying slightly. The winds in the eastern half were, as hitherto, considerably stronger than the normal. Rainfall was now heaviest in the northern districts of the Central Provinces, and the adjacent districts of the North-Western Provinces. Rainfalls exceeding 5 inches were registered at several stations in the central area of depression. The largest amount registered was 12·3 inches at Lalitpur in Bundelkhand. The following table gives average rainfall results for the 24 hours preceding 6 P.M.:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·12	1·08
Central Provinces	20	0·91	5·62
Behar	41	0·43	2·51
Chutia Nagpur	9	*Nil*	0·02
North-Western Provinces	211	0·52	12·30

13th August.

Station.	Barometer, 10 A.M. reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Sutna	29·652	+·060	WSW	13	169
Nowgong	·683	+·038	SW	8	129
Agra	·560	—·081	E	P	P
Saugor	·709	+·020	SW	3	79
Ajmere	·614	—·057	NW	4	82
Jhansi	·549	—·085	NE	7	200
Delhi	·580	—·035	SE	6	130

The observations indicate that the centre was in Bundelkhand between Nowgong and Jhansi and to the south of Agra. The depression was, however, considerably smaller than on the previous day. It filled up rapidly during the preceding 24 hours and on the 13th, and disappeared on the evening of the 13th, as the observations of the morning of the 14th show no trace of cyclonic circulation. The air motion at 10 A.M., was barely up to the normal amount over the cyclonic area. The rainfall during the previous 24 hours

was much less in amount and was diffused over a much larger area than hitherto. The following gives its amount and character :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·31	2 02
Central Provinces	20	0·68	3·12
Behar	41	0·16	1·00
Chutia Nagpur	9	0·59	1·50
North-Western Provinces	211	0·47	8·50

The only rainfall exceeding 5 inches (*viz.*, 8·5 inches) occurred at a station in the Dehra Dun in the North-Western Provinces, and was not directly due to the cyclonic disturbance.

(*No. XXI.*) — *Storm of September 12th to the 17th.*—The distribution of pressure immediately before this storm was approximately normal over the whole of India excepting Bengal and over the north of the Bay. Little or no rain was falling in Northern and Western India. Burma, Bengal, Orissa, and Behar on the other hand were receiving moderate rain at this time, due chiefly to heavy showers more or less local in character and distribution. Pressure was low over the greater part of Bengal, and to a less extent absolutely in Arakan and Pegu. The differences between the barometric readings of the 11th and the mean barometric height of the various stations for the month indicated that pressure was below the average over the north of the Bay and adjacent districts, and that the deficiency was most marked at Akyab. The wind directions on the 11th showed a tendency to cyclonic circulation over the north of the Bay. The wind velocity was, however, below the average at all stations, and was only 50 per cent. of its normal amount at Saugor Island.

The following are the observations at the coast stations near the head of the Bay for the 11th :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·716	—·118	SE	2	67
Chittagong	·756	—·066	Calm	4	83
Saugor Island	·676	—·079	NNW	5	53
False Point	·697	—·073	N	7	95
Vizagapatam	·739	—·021	W	2	83

The following table gives average rainfall data for the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	0·87	3·60
Bengal	102	0·60	7·78
Orissa	15	0·35	2·65

The following gives the observations at the Orissa, Bengal, and Arakan coast stations on the 12th September:—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·722	—·119	SE	1	32
Chittagong	·759	—·057	SE	3	62
Saugor Island	·700	—·055	NW	4	42
False Point	·702	—·068	WNW	5	68

Pressure was very uniform over nearly the whole of Bengal, Orissa, Behar, and the North-West Provinces. The above observations show that cyclonic motion of the air continued in the north of the Bay, and that the central depression was nearest to the Arakan coast. The winds were, however, very feeble and considerably below the average strength at all the stations, and most especially at Akyab.

The rainfall was less in Bengal and Orissa than on the 11th. Its character is shown by the following statement:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
Burma	14	0·92	3·35
Bengal	102	0·57	4·12
Orissa	15	0·29	1·65

13th September.

Station.	Barometer, 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour, for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·702	—·139	SSE	1	33
Chittagong	·736	—·086	Calm	3	60
Saugor Island	·698	—·057	NE	4	42
False Point	·694	—·076	WNW	6	81

The depression extended over the same area as on the 12th, and had apparently not changed at all in character. The absolute depression of the barometer was still greatest at Akyab, and indicated the existence of a centre in about latitude 21° North and longitude 90° East, at which the depression almost certainly did not exceed two-tenths of an inche. The centre was thus nearly midway between Akyab and Balasore. The winds of indraught in the east, as well as in the north and west quadrants, were very feeble. Excessive rain, due to some local disturbance, fell during the previous 24 hours over a small area in Bengal, including part of the Purneah and Dinagepur Districts. Elsewhere the rainfall was very light. The following table gives average rainfall data :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	0·65	2·63
Bengal	102	0·40	12·00
Orissa	15	0·30	1·67

The following statement gives the actual rainfall of the previous 24 hours in the Purneah, Maldah, and Dinagepur Districts, and illustrates its local and excessive character in a small portion of that area :—

	District.	Stations.	Rainfall of previous 24 hours.
North Behar	Purneah	Purneah	35·38
		Kissengunge	0·89
		Arrareah	2·58
	Malda	Malda	1·23
		Chancal	1·12
North Bengal	Dinagepur	Dinagepur	2·50
		Raigunge	2·43
		Mohadebpore	1·60
		Chooramon	12·00

14th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·659	—·182	SE	3	100
Chittagong	·691	—·131	Calm	4	80
Saugor Island	·670	—·085	N	6	64
False Point	·695	—·075	NW	7	94

The wind directions continued to indicate the prolonged existence of the whirl in the north of the Bay. The barometer had fallen slightly at all the stations, and most rapidly at Akyab. The depression had thus deepened in the eastern quadrant, and the centre was hence, almost stationary, as it had apparently been for the previous two days. Winds were, as hitherto, either below, or barely up to, their normal strength, and do not indicate indraught of any intensity. Moderately heavy rain continued to fall over the same limited area in North Behar and Bengal which had received excessive rain on the 13th. The day was almost rainless in the rest of Bengal and Orissa, as is shown by the following :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	14	0·51	1·85
South-West Bengal	47	0·15	1·00
Orissa	15	0·20	1·24

The following table gives the rainfall of the previous 24 hours in the Purneah, Maldah, and Dinagepur districts :—

District.	Station.	Rainfall of previous 24 hours.
Purneah	Purneah	.....
	Kissengunge	1·05
	Arrareah	.....
Malda	Malda	1·03
	Chancal	3·54
Dinagepur	Dinagepur	1·70
	Raigunge	0·59
	Mohadebpore	0·12
	Chooramon	1·41

15th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·657	—·184	SE	5	170
Chittagong	·695	—·121	Calm	2	42
Saugor Island	·646	—·109	NNE	9	100
False Point	·663	—·107	NNW	6	81
Vizagapatam	·735	—·025	WNW	1	40

The barometric observations indicate that the cyclonic vortex was now moving towards the Orissa coast. The depression was increasing at False Point and Saugor Island. The rainfall was small in amount, and was mainly confined to showers in Central Bengal.

The winds were stronger than usual at Akyab, but were either normal or below their average force at the other stations. The following indicates the character of the rainfall of the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	0·53	2·90
South-West Bengal	47	0·45	2·56
Orissa	15	0·29	1·00

16th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29 687	—·154	SE	3	100
Chittagong	·732	—·084	Calm	2	42
Saugor Island	·577	—·178	ENE	10	100
False Point	·547	—·223	NNW	33	446
Vizagapatam	·687	—·073	W	1	42

The whirl had moved in a westerly direction, and was at 10 A.M. to the north-east of False Point. The depression had increased considerably at that station, and was now nearly a quarter of an inch. Very strong winds were blowing on the Orissa coast. At the stations nearest to the centre in Bengal, winds were normal or below their average strength. Unusually heavy rain accompanied the advance of the storm into Orissa, as is shown by the following table :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
South-West Bengal	47	0·58	3·56
Orissa	15	3·84	20·26
Central Provinces	20	0·02	0·20

Falls exceeding 5 inches were recorded at Kendrapara (8·1 inches), False Point (9·65 inches), Bhuddruck (5·32 inches), and Chandbally (20·26 inches). The whirl was

now well marked, the depression considerable, and the rainfall excessive in amount, and concentrated over a small area, whilst the winds were strong in the immediate neighbourhood of the centre. Beyond this, they were feeble in character, and varied little from their normal force.

17th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·705	—·050	SE	13	138
Burdwan	·732	—·035	E	4	121
Hazaribagh	·722	—·035	NE	5	72
Raipur	·679	—·068	N	6	111
Vizagapatam	·667	—·093	W	1	50
Cuttack	·638	—·134	ESE	3	150
Sambalpur	·544	—·193	SW	3	150

The depression crossed the Balasore coast near Chandbally about mid-day on the 16th, and continued to advance westward. On the morning of the 17th, the central depression was near Sambalpur, where the barometer was two-tenths of an inch below its normal height. The wind directions also indicate convergence to a centre near Sambalpur.

The rainfall was now rapidly diminishing in amount, and was no longer excessive over the central area. This is shown by the following statement of average rainfall for the 24 hours preceding 6 P.M. of the 17th:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
South-West Bengal	47	0·15	0·88
Orissa	15	0·58	2·50
Central Provinces	20	0·06	1·28

The returns for the 18th indicate that the cyclonic circulation was completely broken up, and that the depression had disappeared. A few light showers fell in Bengal, Orissa, and the Central Provinces, but they were local in character, and not related to the previous depression.

The more remarkable features of this cyclone were:—

1st.—It formed during a period in which excessive rain was falling over a small area in North Behar and North Bengal. This small land-formed storm, which gave the very large amount of 35·38 inches to Purneah in 24 hours, was

accompanied by comparatively feeble winds near the earth's surface. The anemometer at that station registered only 130 miles for the 48 hours, including the whole period of rainfall. It is a striking illustration of the fact that the atmospheric disturbances of the south-west monsoons proper are chiefly manifested in, and occasionally restricted to, the higher atmospheric strata.

2nd.—It gathered force with extreme slowness, and remained almost stationary at the head of the Bay for some days, probably moving very slowly to the westwards during this period.

3rd.—It gave excessive rainfall over a very limited area in Orissa, over which the winds of indraught were unusually strong.

4th.—It was a very small storm and hardly influenced winds or weather at a distance of more than 100 miles from the centre.

(*No. XXII.*)—*Storm of September 21st to the 28th.*—As already noticed, there was a very marked tendency to the formation of areas of low pressure in the Bay near the Arakan coast during the rainy season of 1879. The chart for the 21st of September shows that a belt of low pressure stretched from Orissa across the head of the Bay into Pegu, and that heavy rain was falling in Pegu.

There were, however, no indications of cyclonic motion on the morning of that day. It apparently commenced during the day, and was clearly marked on the morning of the 22nd. The observations at the nearest coast stations at the head of the Bay for that day are—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·618	—·223	ESE	?	?
Chittagong	·647	—·169	SE	3	62
Jessore	·643	—·141	E	2	100
Saugor Island	·633	—·122	NNE	6	64
Cuttack	·637	—·135	NNE	3	110
False Point	·632	—·133	E	8	114

These observations show that an area of low pressure and cyclonic circulation was established at the head of the Bay, and that the centre was nearer to the Arakan than the Orissa coast. The depression, as measured by the differences between the actual and normal barometric readings, was greatest at Akyab, for which it was ·22″. The winds were below their average strength at the nearest stations, except at Cuttack and False Point, where they were slightly above the normal. No rain was falling in Bombay or Madras.

Light showers were received on the north coast of the Bay. The distribution of rainfall is shown by the following:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
Burma	14	0·74	2·18
East Bengal	24	0·39	4·57
South-West Bengal	47	0·05	0·66
Orissa	15	0·30	2·15

23rd September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·685	—·156	S	2	67
Chittagong	·717	—·099	E	3	63
Saugor Island	·640	—·115	ENE	7	75
False Point	·617	—·153	N	7	100
Cuttack	·665	—·107	NE	3	110
Vizagapatam	·673	—·087	W	2	83

The barometer had risen on the east coast and was falling on the west. The depression was hence advancing westwards, and the centre approaching the Orissa coast. The wind circulation, although distinctly cyclonic, was below the ordinary September strength round the north coast of the Bay. Larger amounts of rain were now falling, more especially in Orissa. The following table gives the rainfall distribution for the 24 hours preceding 6 P.M.:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	1·01	2·90
East Bengal	24	0·88	2·23
South-West Bengal	47	0·47	2·30
Orissa	15	1·81	4·65

The rainfall was hence, not only most general, but heaviest in Orissa.

24th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·569	—·201	E	8	114
Cuttack	·603	—·169	N	2	74
Vizagapatam	·666	—·094	W	1	41
Saugor Island	·647	—·108	ENE	10	105
Raipur	·706	—·041	N	6	120

The centre of the depression crossed the Orissa coast immediately to the south of False Point about 10 A.M. of this day. The barometer at False Point was at that time two-tenths of an inch below the average. Hence it is probable that the central depression did not exceed ·25″. The winds at the nearest stations varied slightly from the September average air motion, and the cyclonic circulation was feeble.

The south-easterly winds in the eastern gradient, gave heavy local showers in East Bengal. The rainfall was most general in Orissa and South Bengal, and was very light in the Central Provinces. The following table gives its character during the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Burma	14	0·72	4·65
East Bengal	24	0·96	6·48
South-West Bengal	47	1·10	3·15
Orissa	15	1·82	4·60
Central Provinces	20	0·12	0·78

25th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Cuttack	29·669	—·103	ESE	2	74
Sambalpur	·558	—·179	SE	3	150
Raipur	·614	—·133	N	7	140
Nagpur	·744	—·031	NW	7	140
Vizagapatam	·666	—·094	W	2	83
Chanda	·769	—·043	NW	5	125

The cyclonic disturbance, although feeble, had advanced almost due west across the Orissa hills during the preceding 24 hours, and was in the Central Provinces, about 50 miles south-west of Sambalpur, at 10 A.M. The storm continued to present the same characteristics as before, *viz.*, unusually small barometric depression at the centre, light cyclonic winds, and moderately heavy rain.

The rainfall was now much less general in Bengal and Orissa, and was heaviest in the Central Provinces, which received an average of 1½ inches, during the preceding 24 hours.

The following gives the distribution of rainfall during the 24 hours preceding 6 P.M. :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Burma	14	0·36	1·40
East Bengal	24	0·72	2·42
South-West Bengal	47	0·54	1·67
Orissa	15	0·89	4·96
Central Provinces	20	1·46	3·95

26th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jubbulpore	29·658	—·119	SE	8	200
Hoshangabad	·667	—·130	NNE	5	167
Amraoti	·684	—·111	W	10	287
Nagpur	·626	—·153	E	9	180
Raipur	·722	—·025	S	7	140

The cyclonic vortex, although apparently a feeble one, as estimated by the barometric depression, or strength of the winds, continued to advance westward without disintegration. Heavy rain now began to fall in connection with it in the Central Provinces, and gave it a further lease of life. The centre at 10 A.M. of the 26th was probably about 20 miles to the north-west of Nagpur, and the central depression probably did not exceed two-tenths of an inch. The cyclonic circulation was more distinctly marked than hitherto, whilst the force of the winds was double their normal strength at the nearest registering stations.

Fairly general and heavy rain fell in the Central Provinces, the Berars, and Central India. It was heaviest in the western quadrant or over the Berars, where an average of 2½ inches fell during the day. The average distribution of rainfall is given below:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
South-West Bengal	47	0·24	1·47
Orissa	15	0·31	1·58
Central Provinces	20	0·92	5·24
Berars	8	2·52	5·79
Central India	14	0·87	4·90

27th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Indore	29·714	—·088	WNW	9	167
Hoshangabad	·705	—·092	ENE	5	167
Khandwa	·679	—·114	W	12	210
Amraoti	·716	—·079	W	10	227
Nagpur	·756	—·023	SW	10	230

The centre had moved nearly due west during the past 24 hours, and was near Khandwa at 10 A.M. The depression was less than on the 26th, and probably now did not exceed ·15″ at the centre. The winds were, as on the preceding day, double their normal September strength at the nearest observing stations. The rainfall, as is shown by the following table, was considerably less in amount, and was now heaviest in Central India:—

	Number of stations.	Average rainfall of the previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Orissa	15	0·10	0·90
Central Provinces	20	0·30	2·42
Berar	8	0·52	1·01
Central India	14	1·08	5·06

28th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jhansi	29·804	+·077	E	?	?
Ajmere	·808	+·051	NE	3	60
Neemuch	·748	—·040	N	9	90
Deesa	·895	+·105	WNW	9	113
Indore	·808	+·006	WNW	8	148
Khandwa	·811	+·018	W	11	183
Hoshangabad	·811	+·014	SW	4	133

The centre advanced to the north-westward during the preceding 24 hours, and was near Neemuch at 10 A.M. of the 28th. The depression was fast filling up, although the cyclonic circulation was still distinctly marked. The gradual dissipation of the disturbance was apparently due to the diminution in the rainfall. The latter change is shown by the following averages:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Central Provinces	20	0·06	0·38
Berar	8	0·72	2·51
Central India	14	0·30	1·35

The cyclonic circulation was no longer in existence on the morning of the 29th. Hence the storm broke up on the evening of the 28th. The following were the most important features of this storm:—

1st.—If the strength of a storm be estimated either by the amount of the depression, or the force of the winds near the centre, the present storm was an unusually feeble one.

2nd.—Notwithstanding its weakness, it surmounted the Orissa Hills and acquired additional energy, so that it intensified to some extent, and marched across the head of the Peninsula through the Central Provinces, and Central India, to the borders of Rajputana.

3rd.—Its dissipation was apparently due to the failure of supplies of vapour from the Bombay coast.

(*No. XXIII.*)—*Storm of October 10th to the 15th.*—This storm was in several respects similar to the preceding. It formed near the Arakan Coast, in the area of

greatest permanent deficient pressure of the year, advanced westward across the head of the Bay, and crossed the Orissa coast near to False Point. Its existence on land was brief, as it did not advance over the Orissa hills.

On the 9th of October, pressure was very low in Arakan, and the adjacent parts of the Bay of Bengal. The same feature was shown on the 10th, when the winds were light, unsteady, and somewhat variable, but did not as yet indicate the commencement of cyclonic circulation. The following 10 A.M. observations of the 10th illustrate the deficiency of pressure in Burma and Arakan antecedent to the cyclone :—

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·814	—·109	N	3	43
Thyetmyo	·745	—·158	SSE	P	P
Akyab	·732	—·183	ENE	P	P
Bassein	·775	—·156	E	P	

The distribution and character of the rainfall at this time near the head of the Bay is shown by the following rainfall table :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	·14	0·63	2·93
South-West Bengal	46	0·17	2·73
Orissa	14	0·08	0·63

11th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as percentage.
Diamond Island	29·823	—·097	WSW	4	57
Thyetmyo	·759	—·136	SE	P	P
Akyab	·687	—·228	ENE	P	P
Chittagong	·773	—·148	Calm.	2	67
Saugor Island	·767	—·127	E	6	104
Cuttack	·771	—·146	Calm	1	45
False Point	·773	—·136	E	4	66

These observations show that a considerable depression was now formed in the neighbourhood of the Arakan coast. The depression at Akyab, the nearest station to the centre, was ·23 inch. The winds at the head of the Bay had changed considerably in direction during the preceding 24 hours, and now indicated that cyclonic motion was established over the head of the Bay. The winds were, however, very light and generally below their October strength, more especially at Diamond Island.

The rainfall over the coast area was, as shown by the following table, small in amount. Hardly any rain was falling at this time over the whole of Western and Northern India.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Burma	14	0·60	1·74
South-West Bengal	46	0·06	0·98
Orissa	14	0·21	0·85

12th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·860	—·060	WSW	8	119
Akyab	·766	—·149	SE	?	?
Chittagong	·799	—·117	E	2	59
Saugor Island	·773	—·121	NNE	6	104
False Point	·771	—·138	N	7	123

The barometer now stood at the same height very approximately at the meteorological stations on the north coast of the Bay. The depression below the October average was also nearly the same in amount as at Akyab. The central depression had moved westward, and was probably midway between False Point and Arakan. The air motion was distinctly cyclonic, but was, except at Diamond Island and False Point, no stronger than it had been on the 11th. The rainfall was now increasing considerably in amount.

The following table gives generally its distribution and character:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Burma	14	0·59	2·47
East Bengal	24	0·67	2·67
South-West Bengal	46	0·32	2·00
Orissa	14	0·44	2·41

13th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·813	—·102	SE	3	125
Saugor Island	·802	—·092	E	6	105
False Point	·800	—·109	N	6	100
Cuttack	·791	—·126	NE	1	45
Vizagapatam	·817	—·078	W	1	50

The barometer had risen slightly at all stations near the head of the Bay, so that the depression was smaller in amount than on the 12th. It was greatest at False Point and Cuttack. The centre was some distance to the east of False Point at 10·A.M. Winds were of normal strength at Saugor Island and Akyab, but were very feeble in the western quadrant of the cyclone.

The rainfall was smaller in amount than on the previous day. Its character is shown by the following rainfall statement:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the previous 24 hours.
Burma	14	0·53	2·65
South-West Bengal	46	0·40	1·72
Orissa	14	0·35	1·72
Central Provinces	20	*Nil.*	0·07

14th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·830	—·079	N	13	217
Saugor Island	·784	—·110	SSE	4	0
Calcutta	·808	—·102	SE	4	110
Berhampore	·835	—·093	E	4	200
Burdwan	·820	—·103	NNE	3	150
Hazaribagh	·847	—·073	NNE	3	60

These observations indicate that the cyclonic vortex had travelled slowly during the previous 24 hours to the west-north-west, and was at 10 A.M. between Saugor Island and False Point, and approaching Balasore. The depression was very small, probably not

exceeding ·15" at the centre. Winds were, as hitherto, feeble, more especially in that part of the eastern quadrant represented by Saugor Island. Moderately heavy rain was now falling in South-West Bengal. The rainfall over the western quadrant (in Orissa) was, on the other hand, very slight. The character and distribution of the rainfall is given by the following:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the preceding 24 hours.
South-West Bengal	46	1·20	7·05
Orissa	14	0·03	0·28
Chutia Nagpur	9	0·04	0·20

15th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Burdwan	29·850	—·073	SSW	2	100
Berhampore	·830	—·098	SW	4	200
Purneah	·837	—·081	ENE	4	210
Patna	·846	—·073	E	?	?
Hazaribagh	·836	—·083	WNW	5	105

The central depression was smaller than on the 14th, and, as indicated by the observations, probably did not exceed a tenth of an inch. The centre had advanced rather rapidly to the north across Chutia Nagpur and was apparently in the neighbourhood of Bhagulpur, but the depression was now ill-defined and breaking up. The winds were light to moderate in force, although still distinctly cyclonic in character. The rainfall was small and decreasing in amount. It was confined to South-West Bengal, North Bengal, and Behar.

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the preceding 24 hours.
Orissa	14	0·06	0·35
South-West Bengal	46	0·35	3·47
Chutia Nagpur	9	0·02	0·11
Behar	41	0·22	1·84

The depression filled up during the afternoon of the 15th, so that there was no trace left of it on the morning of the 16th, when skies were clear, winds light, and weather fine over the whole of Bengal and Behar.

This storm was hence formed at sea under similar conditions to the preceding, and advanced along the same path until it reached Orissa. The relations between the

land and sea areas and the metecrological conditions of Northern and Central India had changed considerably in the interval, and the storm consequently pursued a different path at land. It was unable to surmount the Orissa hills, and hence recurved in Orissa, and passed northwards into Central Behar, where it broke up.

(*No. XXIV.*)—*Storm of October 25th to the 27th.*—The tendency to the formation of small cyclonic vortices off the Arakan coast was shown once more during the year 1879. From the 20th to the 25th, there was a considerable depression in that area. The winds were light and unsteady. They did not indicate the establishment of cyclonic motion until the morning of the 26th. The following gives the observations at the neighbouring coast stations at 10 A.M. of that day :—

26th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·869	—·054	S	16	239
Thyetmyo	·867	—·036	SSE	P	P
Akyab	·739	—·176	SE	4	175
Chittagong	·780	—·136	NNE	2	60
Saugor Island	·801	—·093	N	12	210
False Point	·824	—·085	N	11	193

The centre of the depression was to the west of Akyab, where the barometer was ·16″ in defect. Winds were stronger than the average, except at Chittagong, where light north-north-east airs were blowing. The rainfall during the previous 24 hours was small in amount over the adjacent land area, as is shown by the following results :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the preceding 24 hours.
Burma	14	0·34	1·48
East Bengal	24	0·19	1·73

27th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·830	—·085	WSW	7	350
Chittagong	·772	—·144	WNW	8	267
Dacca	·772	—·139	W	4	200
Silchar	·759	—·181	NNE	4	200

The whirl had advanced rapidly during the past 24 hours and was in Eastern Bengal at 10 A.M. of the 27th. The nearest station to the centre (which was probably at or near Comillah) was Silchar, where the barometric depression was ·18". Winds were considerably above their mean October strength, more especially on the Arakan coast. General rain fell in Eastern Bengal, Arakan, and Burma, and a few stations received heavy falls, more especially Cox's Bazar, where a total of 7·83 inches was recorded at 6 P.M.

The following gives the average rainfall in these areas:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall of the preceding 24 hours.
Burma	14	0·40	2·56
East Bengal	24	0·46	7·83

The cyclonic circulation broke up on the evening of the 27th, as no trace of it is shown in the observations or chart of the 28th, when weather was again fine and skies clear in Eastern Bengal.

(*No. XXV.*)—*Storm of November 1st to the 5th.*—This storm originated in the Gulf of Martaban on the 31st of October and 1st of November under somewhat unusual circumstances. It was a storm of small intensity, and apparently did not influence the weather in the Bay of Bengal to any appreciable extent. It advanced slowly northwards into the northern districts of British Burma, where it broke up and disappeared on the 5th.

The first indications of the disturbance and cyclonic circulation were shown by the observations of the 31st October.

31st October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·944	—·012	SSW	5	83	0·67
Port Blair	·941	+·014	SE	5	73	*Nil.*
Diamond Island	·921	—·002	NNW	3	45	0·47
Bassein	·886	—·045	WNW	?	?	0·11
Rangoon	·882	—·056	N	5	152	*Nil.*
Moulmein	·894	—·025	N	1	42	*Nil.*
Mergui	·832	—·121	WSW	2	133	5·76
Masulipatam	·873	—·037	NE	?	?	1·26

The preceding observations indicate that the south-west monsoon winds recurved over the south of the Bay, from south-west at Nancowry through south-east at Port Blair to north-east on the Coromandel coast. Heavy rain, more or less local in character,

had fallen during the previous 24 hours in the coast districts of the Madras Presidency. For example, Madura received 4·70 inches, Vizagapatam 2·40 inches, and Masulipatam 1·26 inches. Winds were very light at the Andamans and Nicobars. The Burma observations of 1879 are not very trustworthy, and hence they cannot be employed with the same confidence as the Bengal observations. They, however, indicate that winds were stronger than usual, and that there was a tendency to cyclonic circulation and barometric depression over the centre of the Gulf of Martaban, over the south and centre of which strong south-west winds were blowing, and were giving heavy rain on the Mergui coast.

The rainfall during the 24 hours preceding 6 P.M. at the more important stations in Burma is given below :—

Station.	Rainfall of previous 24 hours.	Station.	Rainfall of previous 24 hours.
Mergui	5·76	Diamond Island	0·47
Tavoy	1·95	Bassein	0·11
Moulmein	*Nil.*	Rangoon	*Nil.*
Tounghoo	*Nil.*	Sandoway	*Nil.*
Thyetmyo	*Nil.*	Kyouk Phyoo	*Nil.*
Prome	*Nil.*	Akyab	*Nil.*
Henzada	*Nil.*		

1st November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·935	—·025	SSW	8	148	*Nil.*
Port Blair	·924	—·034	SSW	4	55	0·46
Diamond Island	·835	—·132	NNW	12	145	0·21
Bassein	·804	—·183	NNW	?	?	0·02
Rangoon	·796	—·184	N	9	205	0·01
Moulmein	·796	—·173	N	2	83	0·05
Mergui	·880	—·097	S	6	353	2·70

A considerable fall of the barometer had occurred over the north of the Gulf of Martaban, due to the formation of a small depression. The air motion at the stations

in South Burma indicated convergence to the depression, but of a less regular kind than is usually the case. Winds had strengthened considerably, and were very strong to the south and south-east of the depression. The centre of the depression was apparently near the Moulmein coast in Lat. 15½° N. and Long. 97¼° E. Rain was falling over the north and east coasts of the Gulf of Martaban, but the amounts were not large, except in the Tavoy and Mergui Districts. The indraught towards the vortex from the south had already very considerably diminished the strength of the winds on the Madras coast, and modified their directions. Rain had also ceased to fall in the Madras Presidency.

The following return gives the rainfall at the Burma stations:—

Station.	Rainfall of previous 24 hours.	Station.	Rainfall of previous 24 hours.
Mergui	2·70	Diamond Island	0·48
Tavoy	3·43	Bassein	0·02
Moulmein	0·05	Rangoon	0·03
Tounghoo	*Nil.*	Sandoway	*Nil.*
Thyetmyo	*Nil.*	Kyouk Phyoo	*Nil.*
Prome	0·28	Akyab	*Nil.*
Henzada	*Nil.*		

2nd November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·944	—·016	SSW	12	222	*Nil.*
Port Blair	·913	—·045	SW	9	123	0·90
Diamond Island	·800	—·167	NNW	13	157	4·22
Bassein	·760	—·227	NNW	?	?	4·55
Rangoon	·711	—·269	NE	13	295	1·56
Moulmein	·856	—·113	SE	1	42	0·88
Mergui	·919	—·058	ESE	3	175	2·07

The disturbance had advanced to the north-north-west during the preceding 24 hours. The centre of the depression was to the south-east of Rangoon in Lat. 16½° N. and Long. 96½° E. Winds had again strengthened considerably, and indicated moderately

strong and regular cyclonic circulation. The Madras Presidency continued to have rainless weather, with clear skies and light winds. Heavy rain fell over a large portion of the area of disturbance. It was moderately heavy in the Tavoy and Mergui Districts, which were now beyond the limits of the region proper of cyclonic disturbance. Little or no rain had fallen during the past 24 hours in the eastern and northern quadrants, whilst excessive rain was received with northerly winds in the western quadrant. This can only be ascribed to the obstruction offered by the Yoma Mountains to the air motion in that quadrant. Henzadah, Diamond Island, Bassein, and Rangoon, were all in the western quadrant, and of these four, the stations nearest the hills and farthest from the centre received the largest rainfall.

Station.	Rainfall of previous 24 hours.	Station.	Rainfall of previous 24 hours.
Mergui	2·07	Diamond Island	7·82
Tavoy	3·80	Bassein	4·55
Moulmein	0·88	Rangoon	1·92
Tounghoo	0·06	Sandoway	0·96
Thyetmyo	0·07	Kyouk Phyoo	*Nil.*
Prome	0·34	Akyab	*Nil.*
Henzada	3·09		

3rd November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·932	—·028	SSW	10	185	0·11
Port Blair	·899	—·059	WSW	8	110	0·45
Diamond Island	·855	—·112	NNW	14	169	3·80
Bassein	·778	—·209	WNW	?	?	3·07
Tounghoo	·806	—·166	N	2	105	0·38
Thyetmyo	·776	—·207	NE	3	88	*Nil.*
Akyab	·792	—·206	N	3	136	*Nil.*
Rangoon	·687	—·293	WNW	22	500	9·95
Moulmein	·790	—·179	S	1	42	4·18
Mergui	·867	—·110	ESE	3	176	1·30

The preceding observations indicate that no important change had occurred in the cyclonic circulation. The depression was approximately the same in amount and extent

as on the 2nd, and it had continued to drift slowly in the same direction, *viz.*, north-north-west. The centre was a little distance to the north of Rangoon in Lat. 17½° N. and Long. 96¼° E. The rainfall table given below shows that excessive rainfall had occurred during the previous 24 hours over the southern, south-eastern, and south-western portions of the cyclonic circulation, but that little or no rain was falling in the northern quadrant. The rainfall of the following table is for the 24 hours preceding 6 P.M. of the 3rd, during which the winds at Rangoon shifted from north to south-west. Winds were, as on the 1st and 2nd, light and unsteady on the Coromandel coast, and skies clear.

Station.	Rainfall of preceding 24 hours.	Station.	Rainfall of preceding 24 hours.
Mergui	1·30	Henzada	*Nil.*
Tavoy	1·95	Thyetmyo	0·22
Moulmein	4·18	Toungho	*Nil.*
Rangoon	10·44	Sandoway	0·38
Bassein	3·07	Kyouk Phyoo	0·05
Diamond Island	0·20	Akyab	*Nil.*
Prome	*Nil.*		

4th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·924	—·036	SSW	9	167	0·09
Port Blair	·901	—·057	WNW	6	82	0·08
Diamond Island	·860	—·107	WNW	8	96	*Nil.*
Bassein	·826	—·161	WNW	?	?	*Nil.*
Tounghoo	·823	—·149	Calm	2	105	*Nil.*
Thyetmyo	·791	—·196	NE	4	118	*Nil.*
Akyab	·818	—·180	NNW	3	136	*Nil.*
Rangoon	·812	—·168	WSW	6	136	1·40
Moulmein	·825	—·144	S	1	42	3·63
Mergui	·878	—·099	SW	3	176	1·17

The depression at the centre was now much smaller, and, as determined from the mean pressure of the month of November, did not exceed two-tenths of an inch, but as derived from the mean of the first week of November, almost certainly did not exceed

one-seventh of an inch. The cyclonic circulation was still distinctly marked, but was now comparatively feeble. The centre of convergence, as indicated by the wind directions, was near Prome, and in Lat. 18½° North and Long. 95½° East. The rainfall was now much smaller in amount, and occurred only on the south-eastern quadrant of the circulation. Dry clear weather continued in Bengal and Madras.

Station.	Rainfall of preceding 24 hours.	Station.	Rainfall of preceding 24 hours.
Mergui	1·17	Henzada	*Nil.*
Tavoy	*Nil.*	Thyetmyo	*Nil.*
Moulmein	3·63	Tounghoo	*Nil.*
Rangoon	1·17	Sandoway	*Nil.*
Bassein	*Nil.*	Kyouk Phyoo	*Nil.*
Diamond Island	*Nil.*	Akyab	*Nil.*
Prome	*Nil.*		

5th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·958	—·002	SW	8	148	*Nil.*
Port Blair	·951	—·007	ENE	6	82	*Nil.*
Diamond Island	·914	—·053	NNW	8	96	*Nil.*
Bassein	·874	—·113	WNW	?	?	0·15
Tounghoo	·898	—·074	NNW	1	53	*Nil.*
Thyetmyo	·827	—·156	SE	3	88	*Nil.*
Akyab	·847	—·151	NNW	3	136	*Nil.*
Rangoon	·871	—·109	SW	2	45	2·32
Moulmein	·923	—·046	SW	1	42	1·91
Mergui	·916	—·061	SSW	2	118	*Nil.*

The preceding observations indicate that the depression had almost filled up. It had advanced slowly to the north-north-west during the previous 24 hours.

There was at 10 A.M. no distinct centre of convergence of the air circulation. Winds had fallen off rapidly in strength, and were generally below their average force. They were also somewhat variable and irregular in direction. Moderate showers had fallen at two stations in the south-eastern quadrant. The depression completely filled up during

the afternoon of the 5th, so that there were no traces of its existence on the morning of the 6th. No rain fell in Burma after the 5th, and showers again commenced to fall in the Madras Presidency.

Station.	Rainfall of preceding 24 hours.	Station.	Rainfall of preceding 24 hours.
Mergui	*Nil.*	Henzada	*Nil.*
Tavoy	*Nil.*	Thyetmyo	*Nil.*
Moulmein	1·91	Tounghoo	*Nil.*
Rangoon	1·68	Sandoway	*Nil.*
Bassein	0·15	Kyouk Phyoo	*Nil.*
Diamond Island	*Nil.*	Akyab	*Nil.*
Prome	*Nil.*		

The following gives the position of the centre during the existence of the storm:—

Date.	Position of Centre.		Distance travelled in previous 24 hours.	Rate of motion during previous 24 hours.
	Lat. N.	Long. E.		
November 1st, 10 A.M.	15½	97¼	...	
„ 2nd „	16½	96½	105	4½ miles per hour
„ 3rd „	17½	96¼	75	3 „
„ 4th „	18½	95½	85	3½ „

The more remarkable features of the storm are:—

(1) The almost complete absence of rainfall in the northern quadrant.
(2) The large rainfall in the western quadrant in Southern Burma.
(3) Its origin, apparently due to independent action in the Gulf of Martaban, and not connected with any disturbance in the Bay of Bengal.
(4) The effect of the disturbance in altering the directions of the winds in the neighbourhood of the Andamans and Nicobars, and thus diminishing the rainfall in the Madras Presidency during its existence.
(5) Its slow rate of motion, in which respect it was comparable rather with storms that advance into Bengal during the south-west monsoon period than with those which cross the continent.

(*No. XXVI.*)—*Storm of November 15th to the 20th.*—This was a storm of considerable extent, but of a very diffused character. It was generated in the south of the Bay on the 15th, 16th, and 17th, and advanced to the Madras coast. The cyclonic circulation was less regular than usual, and the centre ill-defined. It was chiefly remarkable for giving moderately heavy rainfall over a very large portion of the Madras coast districts as far north as Ganjam. This was due to the diffused character of the disturbance, and not to its recurvature after reaching the coast near Madras. The first indications of its formation are given by the observation of the 15th November.

15th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·978	+·018	SSW	2	37	*Nil.*
Port Blair	·885	—·073	ENE	5	68	0·12
Diamond Island	30·003	+·036	ENE	8	96	0·59
Vizagapatam	·012	—·012	NE	3	120	*Nil.*
Masulipatam	·002	—·006	NNE	?	?	*Nil.*
Madras	29 961	—·030	N	12	176	1·04
Negapatam	·940	—·027	NE	9	160	3·21
Colombo	·949	—·003	Calm	6	111	2·15

The observations establish that there was a slight deficiency of pressure in the centre of the Bay between the Andamans and the Coromandel coast, and that it was most pronounced at Port Blair. Winds were considerably below their normal strength in the east of the Bay. Moderately strong north-east winds prevailed on the Coromandel coast. The Madras Presidency received an average rainfall of ·77 inch during the preceding 24 hours (as determined from the amounts registered at 21 stations). Negapatam obtained the largest amount (3·21 inches).

16th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·938	—·022	W	2	37	0·70
Port Blair	·929	—·029	SE	6	82	0·03
Diamond Island	·984	+·017	NE	9	108	*Nil.*
Vizagapatam	·990	—·031	NE	3	120	*Nil.*
Masulipatam	·977	—·031	NNE	?	?	*Nil.*
Madras	·959	—·032	NNW	12	176	*Nil.*
Negapatam	·941	—·026	NNW	9	161	0·44
Colombo	·955	+·006	N	7	130	1·28

The centre and south of the Bay was, as on the 15th, an area of slightly deficient pressure, and presented the same conditions of air motion. The rainfall in the Madras Presidency had decreased very considerably in amount. An average of only one-tenth of an inch was received, and the largest amount registered was ·8 inch. Rain was also commencing to fall at the Nicobars and Andamans, and continued on the South Ceylon coast.

17th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·975	+·025	S	2	37	0·05
Port Blair	·952	—·006	SE	6	82	0·88
Diamond Island	·999	+·032	NE	3	36	*Nil.*
Vizagapatam	30·005	—·016	NE	3	120	*Nil.*
Masulipatam	29·988	—·020	NNE	?	?	*Nil.*
Madras	·965	—·026	NNW	12	177	*Nil.*
Negapatam	·951	—·016	NNE	7	125	*Nil.*
Colombo	·953	+·004	NNE	7	130	0·40

The observations of the 17th appeared to indicate that the centre was filling up. There was, however, slight depression in the south-west of the Bay. Winds were, as hitherto very light at the Nicobars and Andamans, and moderately strong on the Coromandel coast. The rainfall of the previous 24 hours was small in amount, averaging two-tenths of an inch over the Madras Presidency. The largest amount registered was ·8 inch.

18th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·926	—·034	W	2	37	0·04
Port Blair	·935	—·023	SE	9	123	0·20
Diamond Island	30·014	+·047	E	7	84	*Nil.*
Vizagapatam	29·985	—·036	NE	5	200	*Nil.*
Masulipatam	·917	—·091	NNE	?	?	0·01
Madras	·851	—·140	NW	13	192	0·43
Negapatam	·906	—·061	SW	9	161	*Nil.*
Colombo	·956	+·007	SSW	7	130	*Nil.*

The depression was now approaching the Madras coast, where the barometer was, in consequence, falling rather rapidly. Winds were considerably stronger, but were of moderate force. Heavy rain now began to fall in the coast districts near Madras. An average of 1·4 inches fell at 22 stations during the day. The largest amount recorded was 6·85 inches at Nellore.

19th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Vizagapatam	29·949	—·072	NE	5	200	0·10
Masulipatam	·813	—·195	NNE	?	?	0·87
Bellary	·948	—·048	NW	3	94	*Nil.*
Bangalore	·941	—·045	W	6	171	*Nil.*
Madras	·944	—·147	SW	19	279	3·28
Madura	·911	—·053	WSW	3	73	*Nil.*
Negapatam	·888	—·079	SW	4	71	*Nil.*
Colombo	·955	+·006	SE	6	111	0·19

The disturbance was at 10 A.M. of the 19th, crossing the Coromandel coast to the north of Madras. It was an unusually small one, the barometric depression at the centre almost certainly not exceeding a quarter of an inch. It drifted north-westward, but commenced to fill up almost immediately. Large amounts of rain fell in the coast districts between Masulipatam and Madras. Ongole received 10 inches, and Guntoor 5·7 inches.

20th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Vizagapatam	29·945	—·076	E	5	200	0·10
Masulipatam	?	?	S	?	?	1·37
Bellary	29·941	—·055	NW	3	94	*Nil.*
Bangalore	·923	—·063	SW	5	143	*Nil.*
Madras	·907	—·084	S	7	103	*Nil.*
Madura	·921	—·043	W	3	73	*Nil.*
Negapatam	·914	—·053	SSW	5	89	*Nil.*
Colombo	·945	—·004	WSW	4	74	*Nil.*

The Masulipatam observations of this period are almost worthless, in consequence of the incapacity of the observer. The depression had passed westward, but was now filling up rapidly, and the cyclonic circulation was irregular. The disturbance disappeared before the evening. The rainfall of the previous 24 hours was small in amount, and confined almost entirely to showers on the Ganjam coast.

The following statement gives the more important features of the distribution and character of the storms of 1879 :—

1st.—The storms were distributed much more equally than usual round the coast area of the Bay.

2nd.—The first storm of the season originated in the middle of May and advanced to the Madras coast.

3rd.—No storm occurred in the interval between the first week of June and the first week of August.

4th.—The Bengal coast and the coast from Gopalpur to Masulipatam were not visited by any storm during the year.

5th.—Five of the nine storms of the year crossed the Orissa coast. Three of these were formed during the intermediate period and advanced into the interior along the line of intersection at the head of the Peninsula, but advanced to a less distance than usual and broke up in South-Eastern Rajputana. Not a single storm advanced as far as Sindh or the Bombay coast.

6th.—There was a marked tendency of the storms of the rainy season to originate in the immediate neighbourhood of the east coast. This tendency was exhibited even more clearly in the October transition period, when two storms were generated quite close to the Aracan coast.

7th.—One local storm formed in the Gulf of Martaban in November. Storms which originate solely in that area and are not due to general disturbance over the greater part of the Bay, are of comparatively rare occurrence. It advanced in the normal direction, north, and was a typical example of this class of storms.

1880.

The meteorology of the year 1880 was marked by large variations from the normal conditions. January was a warmer month than usual, whilst February was slightly colder than the normal. The hot weather set in early in March, and temperature increased with great rapidity. The months of March and April were hence unusually hot over the whole of Northern India. The mean daily temperature for the month of March was 9° above the normal mean at several of the Punjab stations, and was about 5° above the average for the whole of Northern India, the excess increasing from east to west. The variation of the mean monthly temperature of Northern India for the month of April was somewhat less, and nowhere exceeded 8°. The rapid accumulation of heat under favourable conditions was strikingly illustrated by the fact that the lowest temperatures of the year in Northern India were registered generally during the month of February, whilst the maximum temperature of the year occurred in a portion of Behar during the following month of March. Thus, at Durbhanga the absolute maximum temperature of the year (102·9°) was registered only 52 days after the absolute minimum (48·5°). The excessive heat gave rise finally in May to many slight atmospheric disturbances, and an unusually large number of hot-weather storms occurred during the month, which reduced the temperature to the average over the greater part of Northern India. The months of January, March, and April were abnormally dry. A larger amount of rain than usual fell in Northern India in the month of February, which accompanied a cold-weather disturbance, that passed eastwards from the Punjab to Bengal.

During the whole period, January to May, antecedent to the south-west monsoon rains, pressure was in defect over nearly the whole of India. There is strong evidence for the assumption that the hot weather tends to exaggerate previous peculiarities or irregularities in the distribution of pressure, and to introduce new features and variations. The local variations of pressure, or pressure anomalies, which were small in January and February were very marked at the end of the month of May. Pressure was deficient over the whole of India, so that the gradients were slightly steeper than usual. The pressure anomalies, or abnormal variations, were negative over the whole

of Northern and Central India, and increased in amount from Bengal in the east and the Central Provinces in the south to the Punjab. The anomalies were positive for the whole of Southern India, the south and centre of the Bay (as represented by the Nicobars and Andamans), Pegu, and Arakan. They were largest in Ceylon, and the East Coast of India, the Deccan, and Arakan and Pegu; so that a belt of relatively high pressure stretched across from the eastern base of the West Ghats to Pegu.

The commencement of the south-west monsoon rains was followed in the beginning of July by a general relative increase of pressure above the normal, so that during the whole period, July to November, the pressure was as markedly above the average as it had been in defect during the previous half of the year. The rains were abundant in Bengal, Assam, the Carnatic, Mysore, and to a less extent in Burma, and were deficient over the whole of North-West India, the Bombay coast districts, and Ceylon. In fact, those parts of the continent which received their rainfall from the Arabian Sea had a fall generally below the average, whilst those dependent on the Bay of Bengal branch received abundant, and in many districts excessive, rain. The latter current was above its normal strength as a rain-giving current, and the former below its ordinary or average strength.

The line, or belt, of minimum pressure which usually runs across the head of the peninsula from the southern frontiers of the Punjab through Allahabad to Orissa was generally further south than usual. This was especially the case in the month of September, when it ran from Jeypore to Pooree, instead of the normal direction from Allahabad across Sambalpur to Cuttack. The weather was unusually stormy in the hill districts of Northern India during the first week of July, shortly after the commencement of the rains, and excessive quantities of snow fell in the North-Western Himalayas. This preceded the remarkable change in the general character of the pressure already described.

The deficiency in the monsoon rains was, on the whole, greatest and most marked in the North-Western Provinces. Even there, a small tract, including the greater part of Rohilkhand, received excessive rain on several occasions in June and July, and more especially during a storm which advanced from the Bay in the month of September to that district.

The rains set in rather earlier than usual in Bengal and Orissa, and were copious throughout. When the rains failed in August over North-Western and Western India, the fall was excessive in North Bengal, and the break was only partially felt, and of short duration, in the western districts of Behar. The rains continued till the latter part of October, and did not give way in either Bengal or Behar till later than the normal.

The north-east monsoon set in on the Madras coast slightly later than usual. The rainfall of the month of October was below the average over the whole of the coast area of Madras. Heavy rain fell, however, during the month of November, the excess, in a few cases, amounting to nearly 20 inches. The north-east monsoon was hence established over the Madras Presidency almost immediately after the south-west monsoon rains ceased in Bengal, and it gave unusually abundant rain to the eastern and southern districts of the Madras Presidency until the third or fourth week of December.

(*No. XXVII.*)—*Storm of May 30th to June 4th.*—This was a small storm, which formed at the head of the Bay at the commencement of the rains of 1880, and passed northwards through Western Bengal into North Behar, where it broke up.

It was an interesting example of a class of storms which are formed near the head of the Bay during the first advance of the south-west monsoon up the Bay into Bengal. Strong southerly winds, giving squally weather, were established in the south of the Bay in the fourth week of the month of May. They advanced rapidly up the Bay. The rain squalls were most severe near the front of the advancing air current, and increased in intensity as it approached the head of the Bay. Further action in this part of its progress converted the eddying motion near the front into a large atmospheric whirl, which developed slowly on the 28th, 29th, and 30th. The observations of the 29th first indicated its existence.

29th May.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·736	—·121	S	4	150	1·43
Akyab	·693	—·129	SSE	5	147	0·16
Chittagong	·656	—·155	E	4	62	0·03
Saugor Island	·584	—·163	SSW	9	62	*Nil.*
Calcutta	·570	—·164	SSW	4	55	0·55
False Point	·610	—·151	S	11	92	0·04
Vizagapatam	·614	—·157	W	4	103	*Nil.*

The observations of the 29th establish that strong south-west winds were advancing up the east of the Bay. At the head of the Bay, south-south-west sea breezes were giving light winds over the whole of South Bengal. Local showers, due to north-westers, occurred at several stations in the Midnapore and Howrah districts, and the 24-Pergunnahs, which gave amounts exceeding one inch at two of the rainfall-reporting stations only. Over the greater part of Bengal no rain fell. The conditions at the head of the Bay and in Bengal were those which usually obtain at the commencement of the south-west monsoon, and the strong winds in the south of the Bay indicate that it was advancing northwards, and that its front was in about latitude 16° north.

30th May.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·347	—·131	SW	15	188	1·45
Diamond Island	·694	—·168	ENE	4	150	1·21
Akyab	·627	—·195	SE	5	147	0·02
Chittagong	·610	—·201	ESE	4	62	*Nil*
Saugor Island	·579	—·168	S	6	41	0·14
Calcutta	·581	—·153	ESE	3	41	0·21
False Point	·555	—·206	E	7	59	*Nil.*
Vizagapatam	·598	—·173	SE	4	103	*Nil.*

The barometer continued to fall, and was considerably below its normal height. This condition almost invariably holds immediately before the first advance of south-westerly winds up the Bay, accompanying the establishment of the south-west monsoon. Winds were very light at the head of the Bay, and the change of wind at Akyab to

south-east, at Chittagong to east-south-east, and False Point to east, indicated the formation of a cyclonic circulation near the front of the advancing massive south-west atmospheric current, which was now established over the south and centre of the Bay. Moderately heavy rain fell at the Andamans and in Burma. A few showers were received in Bengal, but the amount of the rainfall was very small, and less than on the 24th.

The following table gives average rainfall data for the 24 hours preceding 6 P.M. :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·06	0·50
Bengal — South-West	47	0·12	1·72
Bengal — East	24	0·20	2·60
Bengal — North	31	0·13	2·46
Behar — North	17	0·07	1·20
Behar — South	24	*Nil.*	0·03

31st May.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for the preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.	Rainfall in past 24 hours.
Port Blair	29·735	—·130	SW	15	192	3·16
Diamond Island	·724	—·133	SW	6	95	0·13
Akyab	·634	—·188	SSE	4	118	0·06
Chittagong	·605	—·215	E	5	76	0·02
Saugor Island	·581	—·166	ENE	6	41	1·20
False Point	·586	—·175	E	6	50	*Nil.*
Cuttack	·565	—·176	Calm	1	20	*Nil.*
Calcutta	·593	—·141	ESE	5	69	*Nil.*
Hazaribagh	·589	—·101	SE	8	94	*Nil.*
Jubbulpore	·484	—·224	SW	4	83	*Nil.*
Nagpur	·498	—·204	N	3	48	*Nil.*
Sambalpur	·493	—·118	N	2	80	1·32

The barometer had been almost stationary at the head of the Bay during the previous 24 hours. It was considerably below its normal height, yet winds were very light over the whole of Bengal and Orissa. The wind directions at the coast stations near the head of the Bay indicated more plainly than on the 30th that cyclonic circulation was established over the north of the Bay. Strong winds were blowing as far north as Diamond Island, and were giving moderately heavy rain in Burma, and the Andamans. Rain also commenced to fall in small amounts on the Bengal coast. In the interior of the country, the skies were clear. The rainfall in Bengal is shown by the following statement :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Bengal — South-West Bengal	47	0·26	2·25
Bengal — East	24	0·38	2·02
Bengal — North	31	0·16	1·40
Behar — North	17	0·02	0·33
Behar — South	24	*Nil.*	0·03
Chutia Nagpur	9	*Nil.*	*Nil.*
Orissa	14	0·06	0·39

1st June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·772	—·066	SW	14	128	0·24
Diamond Island	·763	—·041	S	11	128	0·47
Akyab	·682	—·054	SE	6	154	1·25
Chittagong	·630	—·063	E	4	57	1·67
Saugor Island	·599	—·008	ENE	5	36	0·11
Calcutta	·598	—·009	SE	3	47	0·07
False Point	·582	—·050	NNE	7	67	0·05
Cuttack	·580	—·042	NE	3	68	...

The preceding observations indicate clearly the further development of the cyclonic disturbance. Winds in the northern quadrant in South-West Bengal were, as hitherto, very weak. The sky was overcast, and general rain was commencing to fall in the coast districts. The centre of the cyclonic circulation was to the south-east of Saugor Island. The following statement gives the average rainfall in the seven divisions of the province of Bengal:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·71	2·80
South-West Bengal	48	0·29	1·63
North Bengal	31	0·05	0·50
East Bengal	24	0·79	2·80
North Behar	17	*Nil.*	*Nil.*
South Behar	24	0·08	1·22
Chutia Nagpur	9	0·09	0·50

2nd June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·813	+·009	SSW	12	140	1·08
Akyab	·662	—·074	S	9	·231	3·00
Chittagong	·582	—·111	E	4	57	0·04
Dacca	·594	—·049	ENE	4	53	1·95
Jessore	·535	—·106	SE	4	80	0·10
Burdwan	·552	—·056	NE	6	118	1·00
Calcutta	·516	—·091	ENE	8	125	0·53
Saugor Island	·478	—·129	NNE	10	72	2·58
Cuttack	·532	—·090	W	1	23	0·05
False Point	·526	—·106	W	6	57	0·89

The depression on the morning of the 2nd was comparatively a small one, the centre being at a short distance to the south-east of Saugor Island, and moving almost due northwards. Its position at 10 A.M. was very approximately latitude 21° 20′ North and longitude 88° 25′ East. Winds were slightly irregular in the northern and western quadrants, and at the majority of stations in these quadrants, they were, as previously, very light. In one or two cases, more especially Calcutta and Burdwan, the north-easterly winds were stronger than the average winds of the season. The distribution of the rainfall in Bengal is given approximately in the following statement:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	1·63	4·39
South-West Bengal	48	0·53	3·01
East Bengal	24	0·90	6·60
North Bengal	31	0·56	1·45
North Behar	17	0·07	0·80
South Behar	24	0·07	0·32

3rd June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Chittagong	29·620	—·073	SE	10	143	0·71
Dacca	·566	—·077	SSE	12	260	1·13
Berhampore	·455	—·163	E	11	200	...
Burdwan	·363	—·245	E	8	157	0·13
Hazaribagh	·501	—·072	NW	9	100	...
Calcutta	·410	—·197	SSW	9	141	0·81
Saugor Island	·464	—·143	SW	18	130	3·93
False Point	·519	—·113	SSW	10	95	2·86
Cuttack	·529	—·093	SW	1	23	1·52
Jessore	·479	—·142	SE	8	160	1·45

The depression had advanced almost due north during the preceding 24 hours, and the centre was a few miles to the south-west of Burdwan at 10 A.M., in latitude 23° 0′ North, longitude 87° 50′ East. The depression had also intensified during the past day, and now exceeded a quarter of an inch in amount at the centre. Strong southerly winds had set in over the Bengal coast which the centre had crossed during the previous night near the mouth of the Hooghly, and were bringing up much cloud and rain. The

rainfall was very heavy in the districts through which it was passing, more especially the Bankura, Birbhum, and Midnapore districts. In the central and eastern districts of South-West Bengal, the amount of rain was much smaller. Heavy rain was being received over nearly the whole of East Bengal, and the greater part of North Bengal. The distribution of the district rainfall in Bengal is given in the rainfall table, page 335.

The following gives the average amount in each of the divisions of the Province of Bengal:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	1·47	4·60
South-West Bengal	48	1·35	5·00
East Bengal	24	1·17	3·56
North Bengal	31	1·54	5·68
North Behar	17	0·04	0·41
South Behar	24	0·51	2·80

4th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Berhampore	29·470	—·148	SSW	13	217	1·45
Burdwan	·498	—·110	SSW	10	196	1·10
Calcutta	·529	—·078	SW	11	172	1·57
Jessore	·546	—·095	NE	10	200	4·95
Dacca	·576	—·067	S	13	173	0·02
Goalpara	·655	—·002	E	12	245	3·49
Purneah	·440	—·172	ENE	7	180	3·61
Durbhanga	·533	—·065	NE	10	189	0·17
Patna	·532	—·047	E	4	100	0·11
Hazaribagh	·542	—·031	WNW	10	111	2·12
Cuttack	·555	—·067	S	5	114	0·18

The centre had again advanced almost due north, and was at 10 A.M. nearly midway between Berhampore and Purneah in latitude 25° North and longitude 87° 45′ East. The depression was smaller at the centre, so that it had almost certainly commenced to fill up. The whirl had rolled along the edge of the highland of the Sonthal Pergunnahs, and the circulation was maintained by the strong southerly winds, which were blowing across

the Bengal coast, and bringing up much rain. Very heavy rain fell at this time in the districts to the east of its path. Bankoora, Nuddea, Rajshahye, Rungpore, Julpigoree, Darjeeling, Bogra, and Dinagepore, received average amounts varying from 4 to 7 inches during the 24 hours preceding 6 P.M. The general distribution of the rainfall is given below:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·13	1·38
South-West Bengal	48	2·57	7·90
East Bengal	24	1·02	3·18
North Bengal	31	4·92	12·47
North Behar	17	1·00	4·51
South Behar	24	0·88	3·06

5th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Burdwan	29·551	—·057	S	5	98	0·72
Calcutta	·563	—·044	SSW	8	125	0·63
Jessore	·586	—·055	S	4	80	0·31
Dacca	·602	—·041	S	12	173	0·55
Berhampore	·559	—·059	W	14	233	...
Goalparo	·568	—·089	E	16	327	3·73
Purneah	·534	—·078	ENE	16	410	5·25
Durbhangah	·533	— 065	E	4	76	0·27
Patna	·514	—·065	ESE	3	75	...
Hazaribagh	·488	—·085	S	9	100	0·05
Cuttack	·569	—·053	SW	7	159	...

The observations of the 5th establish that cyclonic circulation on the large scale had been broken up during the previous 24 hours. The southerly winds blowing across the Bengal coast had fallen off very rapidly, and were below their average strength at 10 A.M. The only apparent trace of the disturbance was shown by the prevalence of unusually strong winds in the northern districts of North Behar, North Bengal, and Assam, or in the immediate neighbourhood of the hills. But these winds were evidently very local, for, although winds were four times their normal strength at Purneah, they were below it at Patna and Durbhanga, the nearest meteorological stations to the south-west, and west. The districts near the hills received heavy rain during the day. East Bengal also btained moderately heavy rain from the monsoon winds passing over it.

The following table gives briefly the distribution of the rainfall:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·07	0·81
South-West Bengal	48	0·53	7·67
East Bengal	24	2·17	8·23
North Bengal	31	2·92	6 93
North Behar	17	0·69	5·57
South Behar	24	0·15	2·45

The path of the centre through Bengal is defined by the following positions:—

	Position of Centre.		Distance passed over by centre during previous 24 hours.	Average rate of motion during previous 24 hours.
	Latitude, North.	Longitude, East.		
June 2nd, 10 A.M.	21° 20′	88° 25′	...	...
3rd, „	23° 0′	87° 50′	125	5 miles per hour.
4th, „	25° 0′	87° 45′	140	6 miles per hour.

The most important feature of the storm was the very heavy rainfall it gave to the whole of Bengal. The following table gives the average fall, day by day from the 1st to the 5th, of each district in Bengal, and illustrates the amount and distribution of the rainfall.

Station.	1st.	2nd.	3rd.	4th.	5th.	Total.
Burdwan	0·29	0·11	1·31	1·70	0·08	3·49
Bankoora	0·53	1·34	3·86	3·96	*Nil.*	9·69
Beerbhum	0·18	0·29	2 04	3·44	0·05	6·00
Midnapore	0·29	1·09	2·49	1·00	0·58	5·45
Hooghly	0·11	0·35	1·03	3·05	0 02	4·56
Howrah	0·06	0·81	0·44	1·65	0·39	3·35
24-Pergunnahs	0·50	1·00	0·90	2 58	0 54	5 52
Nuddea	0·24	0·09	0·47	3·93	1·99	6·70
Jessore	0 32	0·29	1·06	2 42	0·44	4·53
Moorshedabad	0·10	0 05	0·94	1·52	0 36	2·97
Dinagepore	0·13	0·59	2·66	7 25	1·86	12·49
Maldah	*Nil*	0·08	1·59	2·59	4·38	8·61
Rajshahye	0·20	*Nil*	0·63	6·36	0·26	7·45
Rungpore	*Nil*	0·62	1·29	4·15	4 02	10·08

Station.	1st.	2nd.	3rd.	4th.	5th.	Total.
Bogra	*Nil*	0·78	0·59	5 29	1·62	8·28
Pubna	0·31	0·33	0·47	3·35	1·06	5·52
Darjeeling	*Nil*	0·38	2·10	5·10	1·00	8·58
Julpigoree	0·01	0·51	1·74	5·15	3·31	10·72
Cooch Behar	*Nil*	1·03	2·05	3·74	5·44	12·26
Dacca	1·10	0·36	1·63	0·56	2·45	6·10
Furreedpore	0·90	0·24	0·59	0·53	3·56	5·82
Backerganj	0·55	0·91	2·31	0·83	2·17	6·77
Mymensingh	*Nil*	0·76	1·19	1·39	1·39	4·73
Chittagong	0·28	1·24	0·65	2·51	3·75	8·43
Noakholly	0·45	3·93	0·70	0·94	1 61	7·63
Tipperah	1·13	0·66	0·97	1·29	2 08	6·13

(*No. XXVIII.*)—*Storm of June 25th to the 30th.*—This was a small storm which formed at the head of the Bay in front of an advance of strong monsoon winds. It crossed the Orissa coast, and passed into the Central Provinces, where it gave rain for some time, and then filled up on the borders of the Central Provinces and Central India. Its existence was first indicated by the observations of the 25th June given below:—

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·838	+·034	SE	7	81	1·90
Akyab	·772	+·036	SW	6	154	2·09
Chittagong	·724	+·031	E	5	71	0·04
Saugor Island	·618	+·011	E	10	72	0·15
Cuttack	·583	—·039	Calm	1	23	0·15
False Point	·586	—·046	E	11	105	0·03
Vizagapatam	·613	—·075	SW	4	100	*Nil.*

The barometer was slightly above the normal on the east coast, and below it on the west; winds were generally light and below their average strength; moderate rain was falling in Burma and Aracan, and very light showers in Bengal. The Bombay branch was blowing rather strongly, and gave moderately heavy and general rain at this time to the Bombay Presidency, the Central Provinces, and Central India. The only indication of the commencement of the formation of a cyclonic circulation near the head of the Bay was the shift of wind at Saugor Island and False Point to east.

The following gives the amount and character of the rainfall in Bengal at this time:—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Bengal	South-West Bengal	48	0·22	0·87
	North Bengal	31	0·70	4·50
	East Bengal	24	0·54	2·58

26th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·710	+·006	SSE	10	116	0·29
Akyab	·744	+·008	S	4	103	2·13
Chittagong	·702	+·009	NS	5	71	0·07
Saugor Island	·581	—·026	ENE	9	65	0·40
Cuttack	·542	—·080	NE	2	45	0·77
False Point	·536	—·096	E	8	76	1·75
Vizagapatam	·608	—·080	W	6	150	*Nil.*

The observations indicate that there was now a small depression to the east of the Orissa coast. The rainfall at the coast stations was not large in amount, but was increasing in Orissa. The winds were very light in the northern quadrant. The barometric changes indicated that the depression was as yet of very slight intensity, and that it was moving slowly westwards, the centre being near the Orissa coast to the south of False Point, in latitude 19° 39′ North, and longitude 87° 15′ East.

The following gives the average rainfall in Bengal and Orissa during the previous 24 hours:—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Bengal	South-West Bengal	48	0·28	1·07
	North Bengal	31	0·46	5·00
	East Bengal	24	0·23	1·25
Orissa	Orissa	14	0·66	1·75

27th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·818	+·014	S	8	93	2·89
Akyab	·733	—·003	SSW	5	128	1·65
Chittagong	·689	—·004	ESE	5	71	0·11
Saugor Island	·528	—·079	E	11	79	0·60
Cuttack	·485	—·137	Calm	1	22	0·91
False Point	·421	—·211	ENE	10	95	0·52
Vizagapatam	·597	—·091	W	4	100	*Nil.*

The depression had intensified considerably during the preceding 24 hours. It had apparently moved rather slowly and was near the Orissa coast to the south of False Point, which it probably passed about noon. Winds were very light to the north and west of the centre. A calm was recorded at Cuttack, although it was probably not more than 50 miles to the north-west of the centre.

The following gives rainfall averages for the 27th similar to those of the 26th :—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Bengal	South-West Bengal	48	0·41	2·08
	North Bengal	31	0·18	1·95
	East Bengal	24	0·23	1·67
Orissa		14	1·80	7·59

28th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Vizagapatam	29·574	—·114	W	9	225	*Nil.*
False Point	·491	—·141	Calm	11	105	2·56
Cuttack	·477	—·145	Calm	10	250	1·13
Saugor Island	·535	—·072	SE	15	108	0·15
Calcutta	·539	—·068	ESE	8	125	2·40
Burdwan	·552	—·056	ESE	6	118	0·77
Hazaribagh	·535	—·038	ENE	12	133	0·21
Sambalpur	·423	—·158	NW	5	172	1·01

The depression was at 10 A.M. of the 28th transferred to the eastern districts of the Central Provinces, and the adjacent portions of the Orissa Tributary States. The centre had advanced to the west-north-west after crossing the coast near Pooree about noon of the 27th, and was now to the west of the Orissa hills, and approaching Sambalpur. Moderately strong winds prevailed for some hours at the head of the Bay and in Orissa after the centre crossed the coast. The southerly winds accompanying the depression in the Bay were, however, unusually feeble, and died rapidly away, so that calms were registered at the Orissa stations on the morning of the 28th.

The following table gives the average rainfall of the previous 24 hours in Bengal, Orissa, and Chutia Nagpur :—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Central Provinces	Nagpur	21	1·31	5·03
	Jubbulpore	21	0·36	2·00
	Nerbudda	21	0·77	3·61
	Chhattisgarh	11	0·74	2·35
Bengal	South-West Bengal	48	0·56	5·08
	North Bengal	31	0·24	1·56
	East Bengal	24	0·31	2·87
Orissa	.....	14	0·40	1·40

29th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Cuttack	29·513	—·109	SW	3	68	0·39
Sambalpur	·413	—·168	SW	5	172	0·99
Hazaribagh	·482	—·091	E	12	133	0·02
Sutna	·474	—·087	E	13	134	*Nil.*
Jubbulpore	·574	—·039	NW	5	88	0·24
Nagpur	·600	—·038	W	8	114	1·47
Raipur	·482	—·121	W	18	231	4·15

The depression continued to move in a west-north-west direction, and was now between Sambalpur and Raipur, probably in latitude 22° North and longitude 82½° East. Heavy rain was falling to the west and south-west of the depression, and the strong winds of indraught to the vortex were now chiefly due to the Bombay monsoon current. The depression was of moderate intensity, probably not exceeding two-tenths of an inch at the centre.

The character and distribution of the rainfall of the previous 24 hours are given below :—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Central Provinces	Nagpur	22	1·92	7·01
	Jubbulpore	22	0·73	8·00
	Nerbudda	21	1·57	7·00
	Chhattisgarh	12	1·04	4·15
Bengal	South-West Bengal	48	0·24	2·09
	North Bengal	31	0·01	0·20
	East Bengal	24	0·36	2·05
Orissa	.....	14	0·18	0·65

The rainfall was very light over the whole of Bengal and Orissa, attesting the weakness of the Bay of Bengal current, whilst heavy rain occurred over the whole of the Central Provinces to the west and south-west of the centre.

30th June

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for the preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.	Rainfall in past 24 hours.
Sambalpur	29·426	—·155	SW	3	103	2·12
Hazaribagh	·445	—·128	ENE	10	111	0·01
Allahabad	·453	—·101	ESE	3	91	1·05
Sutna	·445	—·116	SE	9	93	*Nil.*
Jubbulpore	·490	—·123	NW	9	158	0·01
Nagpur	·546	—·092	W	9	129	2·38
Raipur	·455	—·148	W	17	218	*Nil.*
Jhansi	·443	—·110	SW	5	82	0·72

The depression was now commencing to break up. The cyclonic circulation was somewhat irregular, and the barometric depression less in amount, and diffused over a larger area. The rainfall accompanying it was much smaller than on the previous day. The centre of the irregular cyclonic circulation was to the north-north-west of Raipur in latitude 22° 30′ North and longitude 81° East. The disintegration of the disturbance proceeded rapidly during the day. There were no traces of its existence shown by the observations of the 1st July. The storm hence terminated on the evening of the 30th. The following table gives average rainfall data of the Central Provinces for the 30th June :—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Central Provinces	Nagpur	22	1·86	7·30
	Jubbulpore	22	0·27	1·01
	Nerbudda	21	0·45	3·00
	Chhattisgarh	12	0·79	3·20

The preceding averages show that the total rainfall of the Central Provinces on the 30th was much smaller than on the 29th, and was only heavy in the Nagpur Division. Ordinary south-west monsoon weather, with occasional showers, obtained from the evening of the 30th.

The chief features of the storm were—

1st.—Its feeble character and slight intensity in the Bay and during its passage through Orissa.

2nd.—Its slight increase for a period of about 36 hours in the Central Provinces, which accompanied, and was evidently due to, a moderate inrush of westerly winds, laden with aqueous vapour.

The path of the centre is given by the following data:—

Date.	Position.		Distance passed over during previous 24 hours.	Average velocity during previous 24 hours.
	Latitude.	Longitude.		
June 26th	19°30′N.	87°15′E.	...	...
„ 27th	19°45′N.	86°15′E.	70	3
„ 28th	21° 0′N.	84°45′E.	135	5½
„ 29th	22° 0′N.	82°30′E.	150	6
„ 30th	22°30′N.	81° 0′E.	100	4

(*No. XXIX.*)—*Storm of July 14th to the 17th.*—This was a very small storm, and of little importance. It formed at the head of the Bay, and advanced westwards across the Balasore coast. It then marched west-north-west along a path further to the north than is usual with this class of disturbance. It passed along the southern borders of Chutia Nagpur, through the north-eastern districts of the Central Provinces, into Bundelkhand, diminishing in intensity during its march, until its disappearance in Bundelkhand.

14th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·662	—·147	SSW	8	88	4·15
Akyab	·515	—·214	SSE	4	111	0·10
Chittagong	·470	—·216	ESE	5	69	*Nil.*
Saugor Island	·429	—·167	NE	6	45	0·48
False Point	·449	—·177	WNW	9	93	2·20
Vizagapatam	·543	—·123	W	4	9	0·30

The 10 A.M. observations of this day show that there was a considerable depression at the head of the Bay. The Burma observations indicate that it was due to an advancing humid current. The depression was greatest at Akyab and Chittagong, or immediately in front of the advancing wave. Winds were very feeble in Bengal, but had shifted round in the usual manner on the approach of a disturbance at the head of the Bay, and formed part of the general cyclonic circulation already established at the head of the Bay. Very little rain was falling at this time in Bengal. The following table gives data illustrating its distribution:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	17	1·67	6·35
East Bengal	24	0·18	2·00
South-West Bengal	48	0·05	0·52
Orissa	14	0·79	2·20

15th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·731	—·078	SSE	9	100	3·83
Akyab	·682	—·047	SSE	7	194	0·47
Chittagong	·562	—·124	ESE	6	83	0·62
Saugor Island	·416	—·180	ESE	10	75	0·68
False Point	·371	—·255	NNW	9	93	0·70
Vizagapatam	·564	—·102	W	4	93	0·20

The depression had developed slightly during the previous 24 hours, and was now in the north-west angle of the Bay. Strong southerly winds had advanced north as far as Akyab, and winds were strengthening in South Bengal. Rain was falling in larger amounts over the coast area of the north of the Bay, and more especially in Orissa, as is shown by the following data :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burma	17	0·75	3·40
East Bengal	24	0·28	1·37
South-West Bengal	48	0·18	0·92
Orissa	14	1·22	3·56

16th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nagpur	29·564	—·089	W	9	127	0·18
Raipur	·525	—·090	W	10	88	0·61
Sambalpur	·543	—·073	S	3	100	0·89
Hazaribagh	·518	—·065	ESE	16	186	0·09
Sutna	·488	—·086	ENE	11	117	0·58
Jubbulpore	·484	—·139	N	5	100	2·00

The centre of the depression had crossed the Orissa coast at about noon of the preceding day, and was, at 10 A.M. of the 16th, on the borders of Chutia Nagpur and the Central Provinces in about latitude 23° North and longitude 82° East. Its passage across the Orissa hills had not been followed by a large accession of aqueous vapour from the

west coast. Hence the rainfall was moderate in amount, and the depression was smaller and rapidly diminishing. The following table gives average rainfall data for the previous 24 hours:—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Bengal	South-West Bengal	48	0·26	0·84
	Orissa	14	0·40	1·95
Central Provinces	Nagpur	21	0·65	2·60
	Jubbulpore	14	1·49	3·86
	Nerbudda	18	0·59	4·54
	Chhattisgarh	10	0·93	2·95

17th July.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Saugor	29·512	—·091	SW	4	87	·110
Jubbulpore	·552	—·071	W	7	135	0·95
Sutna	·487	—·087	SW	9	96	...
Nowgong	·500	—·079	NNW	2	43	...
Allahabad	·512	—·050	E	6	162	0·06
Lucknow	·513	—·047	ENE	4	105	...

The disturbance was now in the area represented by the stations of Allahabad, Sutna, Nowgong, and Saugor. The central depression was much smaller than on the 16th, and probably did not exceed a tenth of an inch. The winds were moderate in force. The rainfall in connection with it was much less than previously, as is shown by the following averages:—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Central Provinces	Nagpur	21	0·59	4·95
	Jubbulpore	14	0·79	2·60
	Nerbudda	18	0·32	1·50
	Chhattisgarh	10	0·18	0·90

The depression completely filled up before the morning of the 18th July.

(*No. XXX.*)—*Storm of July 31st to the 9th August.*—This storm is briefly described in Mr. Blanford's report for the year 1880, page 153. The first indications of its existence are given by the observations at the coast stations on the 31st July.

31st July.

Station.	Barometer, at 10 A.M. reduced to 32° and to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·647	—·122	SSE	4	100
Chittagong	·584	—·156	ENE	2	28
Saugor Island	·578	—·078	NE	4	30
False Point	·606	—·075	NNW	6	65
Vizagapatam	·623	—·091	W	2	54

The depression (as shown by the variations from the mean) was greatest at the north-east coast stations. It is hence probable that it was forming at this time off the Aracan coast.

The average rainfall of the previous 24 hours is given in the following table :—

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, July.	Heaviest rainfall during previous 24 hours.
Burmah	15	1·07	0·96	4·25
East Bengal	24	0·13	0·56	1·50
South-West Bengal	48	0·20	0·47	1·50

1st August.

Station.	Barometer, 10 A.M., reduced to 32° and to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·626	—·143	SE	4	125
Chittagong	·599	—·141	E	3	44
Saugor Island	·542	—·114	ENE	8	72
False Point	·511	—·170	N	5	56
Vizagapatam	·615	—·099	W by N	3	106

The depression had extended westward (as shown by the False Point barometric reading), and the centre was probably about midway between False Point and Akyab. Burmah was receiving moderately heavy rain from the moist current in the eastern quadrant.

The following table gives average rainfall data for the 1st August :—

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, August.	Heaviest rainfall during the previous 24 hours.
Burmah	15	1·34	0·85	6·50
Bengal	103	0·20	0·47	1·80
Orissa	14	0·43	0·39	1·16

2nd August.

Station.	Barometer, 10 A.M., reduced to 32° and to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·612	—·157	ESE	7	206
Chittagong	·579	—·161	E	3	56
Saugor Island	·561	—·095	NE	10	89
Cuttack	·549	—·130	NNE	1	50
Vizagapatam	·613	—·101	W	3	99

The preceding observations show that the depression had concentrated slightly, but had apparently not advanced much westwards. Moderate rain continued to fall in Burmah, and was extending to the Chittagong district. The weather in Bengal was unchanged, and light northerly winds, passing clouds, and a few light local showers, were its chief features. The sky, however, gradually became overcast in Orissa and South-West Bengal during the day.

The following table gives rainfall averages of the 24 hours preceeding 6 P.M. :—

	Number of stations.	Average rainfall for previous 24 hours.	Average daily rainfall, August.	Heaviest rainfall during previous 24 hours.
Burmah	15	1·13	0·85	3·80
Chittagong Division	10	0·76	0·68	2·50
Bengal (Chutia Nagpur excluded)	103	0·23	0·47	2·50
Orissa	14	0·34	0 39	1·26

3rd August.

Station.	Barometer, 10 A.M. reduced to 32° and to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·701	—·134	SSW	13	180
Akyab	·639	—·130	SE	7	220
Chittagong	·581	—·159	E	3	46
Saugor Island	·494	—·162	NE	9	86
Cuttack	·502	—·177	WNW	3	108
Vizagapatam	·594	—·120	W by N	3	99

During the preceding two or three days, the north-easterly winds on the west coast of the Bay had been diminishing in strength. On the 1st of November, winds were unusually light over the whole of the south and centre of the Bay. The recurvature of the south-west winds over the centre of the Bay tended to give a feeble and somewhat irregular cyclonic circulation. The rainfall, from the 30th to the 1st, in the Madras Presidency, as indicated by the returns of the meteorological stations, is given in the following table :—

	Average rainfall of previous 24 hours in the Madras Presidency.	Heaviest rainfall of previous 24 hours in the Madras Presidency.
October 30th	0·38	1·46
„ 31st	0·40	1·56
November 1st	0·74	4·80

Hence the rainfall was increased slightly in amount during this period.

2nd November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·981	+·021	SE	3	56	...
Port Blair	·980	+·022	SE	6	82	0·10
Rangoon	30·017	+·033	S	3	68	...
Akyab	·010	+·009	SSE	2	91	0·05
Vizagapatam	29·947	—·077	ENE	1	40	0·10
Masulipatam	·950	—·063	NE	1	?	0·01
Madras	·960	—·033	N by E	4	59	0·25
Negapatam	·936	—·031	WNW	1	18	...

Pressure was above the average on the Aracan coast, and below it on the Coromandel coast. Although the humid winds blowing into the Bay from the south were very feeble, they were continued as south-east, east, and north-east light winds over the centre of the Bay, and discharged rain over the Coromandel coast and adjacent districts, but the amount was considerably smaller than on the previous three days. The following gives rainfall data for this day :—

Presidency.	Average rainfall of previous 24 hours.	Heaviest rainfall of previous 24 hours.
Madras	0·19	1·39
Bengal	*Nil*	0·08

3rd November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·980	+·020	ESE	1	19	...
Port Blair	·966	+·008	SSE	7	96	0·67
Akyab	·949	—·052	NE	4	182	2·25
Chittagong	·921	—·099	ENE	2	61	0·11
Saugor Island	·881	—·155	NNW	7	117	...
False Point	·904	—·147	NNE	8	129	0·03
Vizagapatam	·913	—·111	ESE	3	120	...
Madras	·961	—·032	N by W	6	88	0·01
Negapatam	·954	—·013	WNW	0	0	0·28

A considerable diminution of pressure had occurred at the stations on the north and north-west coasts, indicating that an area of depression was forming between the Arakan and Ganjam coasts. The wind circulation was somewhat irregular on this supposition, but the meteorology of the 4th and 5th shows that this was due to the ill-defined character of the disturbance. Winds were exceedingly light in the south of the Bay, as evidenced by the Nancowry and Negapatam returns, hence proving that there was no large influx of aqueous vapour from the south. The following table gives average rainfall data for the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Madras Presidency	12	0·37	2·20
East Bengal	22	0·34	2·21
South-West Bengal	47	0·04	0·52
North Bengal	23	0·03	0·65

4th November.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·964	+·004	SE	2	37	...
Port Blair	·961	+·003	S	5	69	0·04
Akyab	·871	—·130	S	6	273	6·65
Chittagong	·882	—·138	NE	3	91	0·03
Saugor Island	·877	—·159	NNW	7	117	...
False Point	·902	—·149	N	7	113	...
Vizagapatam	·931	—·093	W	1	40	...
Madras	·960	—·033	N	2	29	0·01
Negapatam	·946	—·021	NE	0	0	...

The disturbance had, as is frequently the case with those that pass into the Central Provinces, developed considerably, and entered into a second stage of growth and activity. The central depression slightly exceeded a quarter of an inch, and was as large in amount as when it was fully formed in the Bay of Bengal. The centre was between Jubbulpore and Saugor at 10 A.M. in latitude 23° 30′ North and longitude 79° East. The winds were moderate in force, and generally below their average strength at the stations nearest the centre, whilst strong winds prevailed at the more distant stations in the southern and western quadrants. Little or no rain was falling in the northern half of the depression. On the other hand, rainfall was excessive in the southern half, where westerly winds prevailed.

The following table gives the average rainfall in the four divisions of the Central Provinces for the previous 24 hours:—

Province.	Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during the previous 24 hours.
Central Provinces	Nagpur	22	0·52	3·02
	Jubbulpore	22	0·75	2·70
	Nerbudda	21	2·83	9·68
	Chhattisgarh	12	0·19	1·40

7th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Jubbulpore	29·525	—·159	S	9	184	*Nil.*
Allahabad	·552	—·086	SE	5	161	0·25
Agra	·526	—·112	NE	7	159	*Nil.*
Jhansi	·465	—·168	ESE	5	143	0·83
Ajmere	·534	—·129	NE	?	?	0·18
Neemuch	·510	—·187	NNW	11	96	1·15
Indore	·576	—·157	WSW	10	156	5·61
Khandwa	·572	—·146	SW	10	133	1·80
Hoshangabad	·552	—·175	SSW	16	444	7·06
Pachmarhi	?	?	WSW	14	200	6·17
Seoni	·591	—·097	SW	12	267	0·05
Nagpur	·587	—·123	SW	11	204	*Nil.*

The storm area now covered the Scindia, Holkar, and Bhopal States of Central India. The position of the centre can only be determined roughly on account of the paucity of observatories in that region. Judging from the barometric readings and wind directions at the nearest stations, it was probably in latitude 24° 40′ North and longitude 78° 15′ East. Very strong westerly and south-westerly winds prevailed over the southern half of the depression, where also heavy rain continued to be received. Hardly any rain fell in the northern portion of the depression, except in the immediate neighbourhood of the centre. The following table gives the average rainfall in the Central Provinces during the previous 24 hours:—

Province.	Division.	Number of stations.	Average rainfall of previous 25 hours.	Heaviest rainfall during the previous 24 hours.
Central Provinces	Nagpur	22	0·42	2·00
	Jubbulpore	22	0·11	0·43
	Nerbudda	21	0·07	4·37
	Chhattisgarh	12	0·22	1·00

8th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Deesa	29·651	—·055	SW	13	112	6·98
Mount Abu	P	P	SW	14	126	6·29
Neemuch	·599	—·098	SW	6	52	2·47
Ajmere	·549	—·114	NE	6	107	0·25
Agra	·578	—·060	E	9	205	0·42
Delhi	·571	—·045	NE	6	130	*Nil.*
Sirsa	·529	—·068	E	15	273	*Nil.*
Bickaneer	·465	—·127	NNE	8	125	0·05

The depression was now filling up. The centre had advanced to the west-north-west during the previous 24 hours, and was in latitude 25° 40′ North and longitude 75° 15′ East at 10 A.M. The winds were less regular, and the cyclonic circulation weaker than it had been during the previous two days. The rainfall was generally smaller in amount. Moderately heavy rain occurred over the southern and western quadrants during the day, and light showers in the remaining quadrants.

9th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Deesa	29·690	—·016	SW	11	95	0·79
Ajmere	·636	—·027	SW	3	54	0·97
Agra	·640	+·002	SW	7	159	0·11
Delhi	·587	—·029	SE	7	152	*Nil.*
Sirsa	·580	—·017	E	12	218	*Nil.*
Bickaneer	·464 P	—·128 P	N	5	78	0·01
Mooltan	·596	+·022	NW	1	32	*Nil.*
Jacobabad	·577	+·092	SE	4	93	*Nil.*

The Bickaneer barometric observations at this period cannot be relied on. The wind observations show that the depression had advanced to the north-westward. It was, however, now rapidly filling up, and no trace of its existence is shown by the observations of the 10th. The rainfall was also small in amount, and ceased before the evening of the 9th. The following were the only amounts exceeding one inch registered at the stations in Rajputana and Central India :—

	Inches.
Mount Abu	4·29
Jodhpur	2·04
Ulwar	1·50
Erinpura	1·10

The path of the centre of the depression is given by the following data :—

Date.	Position of Centre.		Distance travelled by centre during previous 24 hours.
	Latitude.	Longitude.	
August 3rd	20° 45′ N.	87° 15′ E.	...
„ 4th	21° 15′ N.	86° 15′ E.	...
„ 5th	22° 10′ N.	83° 10′ E.	...
„ 6th	23° 30′ N.	79° 0′ E.	300
„ 7th	24° 40′ N.	78° 15′ E.	110
„ 8th	25° 40′ N.	75° 15′ E.	170
„ 9th	28° 0′ N.	74° 0′ E.	140

The following were the most remarkable features of the cyclone :—

1st.—The long period before it broke up.

2nd.—The heavy rainfall in the southern half of the depression, more especially when contrasted with that of the northern half.

(*No. XXXI.*)—*Storm of August 18th to the 25th.*—This storm is an example of a class of frequent occurrence, storms which are feeble at sea, and develop after crossing the coast. The chief feature of these storms is the heavy rainfall which occurs in some part of the area over which they advance, and which is, therefore, probably the efficient cause of their further development at land.

On the 17th, moderately strong westerly winds were blowing across the Central Provinces, Chutia Nagpur, and Orissa, into South-West Bengal. This frequently precedes the formation of small whirls in the north of the Bay. Light to moderate rain was falling in Burmah and Assam. Elsewhere there were only a few local showers of no importance.

In the course of the afternoon, or evening, of the 17th, a whirl began to form at the head of the Bay, and its existence is clearly indicated by the following observations at the coast stations near the head of the Bay on the morning of the 18th:—

18th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·715	—·053	SW	3	96
Chittagong	·663	—·067	SE	5	81
Saugor Island	·605	—·070	NE	4	37
False Point	·607	—·075	NW	5	56
Vizagapatam	·687	—·026	WNW	3	89

Pressure was slightly below the average of the day at the coast stations. It is probable that the depression of the barometer at the centre of the whirl below the mean of the month did not exceed a tenth of an inch at 10 A.M. The winds were light, more especially at Saugor Island.

The following table gives rainfall data for this day :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours
Burmah	15	0·96	2·30
Bengal	103	0·54	7·98
Orissa	14	0·80	3·11

19th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·702	—·066	SSW	5	161
Chittagong	·651	—·079	SE	5	80
Saugor Island	·618	—·057	N	4	37
False Point	·632	—·050	WNW	6	67
Vizagapatam	·705	—·008	NE	3	88

The preceding observations show that little change had taken place during the previous 24 hours. There were no further signs of intensification of the vortex. Winds were below their average strength, except at Akyab. Moderate rain was falling in Burmah, Bengal, and Orissa, as is shown by the following:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burmah	15	1·11	2·88
Bengal	103	0·52	6·31
Orissa	14	0·77	4·70

20th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·815	—·023	SW	9	129
Akyab	·696	—·072	SE	4	129
Chittagong	·673	—·057	E	4	64
Calcutta	·631	—·042	NE	3	51
Saugor Island	·620	—·055	NNW	5	47
False Point	·653	— 029	WNW	7	78

The preceding observations indicate that the cyclonic motion still continued in the Bay, but that no change of importance had taken place. The depression was evidently small, and probably did not exceed a tenth of an inch. The air motion was feeble, and considerably below the average of the month at all the neighbouring land stations except Akyab and Diamond Island, where it was slightly in excess, but to a less extent than on the 19th.

Light to moderate rain was falling over Burmah, Bengal, and Orissa, as is shown by the following statement:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burmah	15	0·86	3·16
Bengal	103	0·33	5·46
Orissa	14	0·31	1·00

21st August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·762	—·006	S	4	129
Chittagong	711	—·019	ESE	4	64
Saugor Island	·631	—·044	ENE	6	55
False Point	624	—·058	SW	9	100

The observations establish that the disturbance was now advancing to the coast of the north-west angle of the Bay, between False Point andSaugor Island. The depression, as shown by the barometric readings of the two stations of Saugor Island and False Point, each probably not more than 50 or 60 miles from the centre, was very small, and almost certainly did not exceed a tenth of an inch. The winds of Saugor Island were of little more than half their average strength.

Heavy rain was now falling in Orissa. The following gives the rainfall data of the 21st for Burmah, Bengal, and Orissa:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Burmah	15	1·15	3·52
Bengal	103	0·29	3·44
Orissa	14	2·56	7·93

22nd August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·647	—·035	W	14	155
Saugor Island	·611	—·064	ESE	11	101
Calcutta	·649	—·024	ESE	9	180
Burdwan	·657	—·011	E	5	125
Hazaribagh	·682	+·024	NE	5	66
Sambalpur	·703	+·054	W	1	40

The central depression had moved very slowly during the previous 24 hours, and was probably in the immediate neighbourhood, and to the west, of Balasore. The depression was, as hitherto, small, not exceeding a tenth of an inch at the centre. The winds were slightly above their normal strength over the eastern quadrant, in which were False Point, Calcutta, Saugor Island, and Burdwan, and below it over the western half of the depression. The barometric changes at this time indicated that it was filling up. This is confirmed by the rainfall returns, which show that moderate diffused rain was falling over the whole of Bengal and Orissa, but that nowhere was excessive local rainfall received.

The following gives the average rainfall in Bengal and Orissa during the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Arakan	3	1·62	4·19
Orissa	14	0·52	2·03
South-West Bengal	48	0·57	2·80
East Bengal	24	0·53	1·72
North Bengal	31	0·50	1·45

23rd August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·693	+·018	SSE	15	138
Calcutta	·697	+·024	SSE	6	101
Burdwan	·687	+·019	SE	6	150
Hazaribagh	·683	+·025	ENE	7	93
Sambalpur	·708	+·054	SW	1	40
Cuttack	·695	+·016	WSW	2	67

The depression was on the morning of the 23rd a very slight one, although the cyclonic motion of the air was still well marked. The centre had advanced slowly in a north-west direction, and was probably nearly midway between Hazaribagh and Saugor Island, and in the neighbourhood of Chyebassa. The barometric readings at all the neighbouring stations were, however, slightly in excess of the average for the month. The depression had filled up almost completely during the preceding 24 hours, and would have disappeared, if moderately heavy local rain had not commenced in Chutia Nagpur. The air motion was either normal in amount, or slightly in excess in the eastern portion of the disturbance.

The character of the rainfall for the 24 hours preceding 6 P.M. is shown by the following:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·20	1·50
South-West Bengal	48	0·35	1·60
Chutia Nagpur	9	1·42	4·18
Central Provinces	24	0·16	1·65

24th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Berhampore	29·688	+·008	S	3	75
Purneah	·677	+·013	E	2	67
Patna	·656	+·008	NE	1	33
Hazaribagh	·660	+·002	W	5	63

The returns for the 24th indicate that the chief features of the cyclonic vortex and barometric depression were the same as on the 23rd. The central depression had moved nearly due northwards, and was probably in the Sonthal Pergunnahs, and 80 or 90 miles to the west of Berhampore. The barometric readings at all the neighbouring stations were slightly in excess of the average of the month.

The air motion was very feeble in the immediate neighbourhood of the vortex. Heavy rain now fell in South and North Behar, as is shown by the following table The rainfall was more localised than before, and was excessive in South Behar:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South Behar	18	2·49	5·88
North Behar	23	1·35	3·88
South-West Bengal	48	0·25	1·25
Orissa	14	0·08	0·70
Chutiá Nagpur	9	0·25	0·53

25th August.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Berhampore	29·655	—·025	SW	3	75
Purneah	·652	—·012	E	6	200
Durbhanga	·673	+·019	NE	5	125
Gya	·694	+·026	NW	4	133
Patna	·696	+·048	E	1	30
Hazaribagh	·686	+·028	WNW	11	137

Pressure was now nearly uniform over Behar and Bengal, and the barometric readings above the average, except at Purneah and Berhampore. The air motion indicated convergence to a centre near to, and south of, Purneah. The rainfall was heaviest in North Behar, but was much smaller than on the preceding day. The following table shows its character:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
North Behar	23	0·83	5·37
South Behar	18	0·60	2·59
Chutia Nagpur	9	0·07	0·37
Orissa	14	0·06	0·55

The cyclonic circulation broke up on the afternoon of the 25th, as there are no signs of its existence in the meteorological returns for the 26th.

The preceding storm was characterized by the following features, which are deserving of notice:—

1st.—It was a very feeble storm and marked throughout by unusually weak winds. The cyclonic circulation, although distinctly marked near the earth's surface, was very slight, more especially in the northern and western quadrants.

2nd.—The barometer during a large part of its existence was slightly above the normal, and the depression at the centre relative to the outer portion of the storm area was very small.

3rd.—Although it was, in the features of air motion and barometric depression, an exceedingly weak vortex and disturbance, it gave heavy rain over the land area through which it passed. The only apparent motive power which maintained its existence on the 24th and 25th was, in fact, due to the rainfall.

(*No. XXXII.*)—*Storm of September 12th to the 19th.*—This storm was one of the most remarkable of the year. During the latter part of its existence it occasioned abnormally heavy rainfall in Rohilkhand and the hill district of Kumaon. It is briefly described in the India Meteorological Report for the year 1880, pages 156-57.

It followed a somewhat prolonged break in the rains over Northern India. This break was most pronounced in the North-Western Provinces, where it lasted from the 1st to the 15th of the month. In Bengal it extended from the 5th to the 13th.

Its history commences from the 12th September, when the Bengal coast observations first indicated the establishment of a cyclonic whirl near the head of the Bay.

12th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·812	—·046	W	7	103
Akyab	·778	—·057	S	4	140
Chittagong	·731	—·091	E	3	62
Saugor Island	·707	—·048	NE	5	55
False Point	·699	—·066	NE	7	100
Vizagapatam	·696	—·067	W	2	91

A slight depression extending over the head of the Bay, and accompanied with feeble cyclonic circulation, was established on this day. The depression, as gauged by the barometric observations taken at coast stations, was very small, and was apparently

greatest in the neighbourhood of the Chittagong coast. The following table gives rainfall averages of the preceding 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Burmah	15	0·62	0·62	1·25
Bengal	103	0·14	0·39	1·25
Orissa	14	0·16	0·35	0·61

13th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·865	+·016	S	9	128
Akyab	·830	—·005	SE	5	180
Chittagong	·793	—·029	ESE	4	93
Saugor Island	·756	+·001	ENE	6	61
False Point	·727	—·038	N	8	103
Vizagapatam	·771	+·008	SE	2	91

The barometer had risen during the preceding 24 hours, and pressure was at 10 A.M. of the 13th approximately normal over the north of the Bay and in Bengal. The wind directions indicate the continuance of the cyclonic air motion over the same area as on the 13th. Very little rain was falling at this time in Northern and Western India, and was confined to a few local showers in the eastern districts of Bombay. Moderately heavy rain appears from the logs of one or two vessels in the Bengal Meteorological Office to have been falling near the head of the Bay, and thus maintained the cyclonic circulation.

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Burmah	15	0·39	0·62	1·88
Bengal	103	0·27	0·39	5·10
Orissa	14	0·80	0·35	2·24

14th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29·872	+·037	SE	6	193
Chittagong	·856	+·034	ENE	3	73
Saugor Island	·746	—·009	ESE	10	103
False Point	·684	—·081	SE	12	164
Cuttack	·643	—·024	ESE	5	208
Sambalpur	·653	—·084	NE	2	100
Vizagapatam	·694	—·159	WNW	2	105

The central depression was apparently a small one, and did not exceed two-tenths of an inch. The disturbance was due to an extensive and diffused cyclonic circulation, which was at this time established over Ganjam, the Central Provinces, Orissa, South-West Bengal, and the adjacent sea area. The central depression at 10 A.M. was probably in the immediate neighbourhood of the Ganjam coast, near Gopalpur. The cyclonic rainfall previous to the morning of the 14th was confined to the eastern and southern quadrants in the Bay of Bengal, and was now commencing in Orissa. The following table gives average rainfall results for the 24 hours preceding 6 P.M.:—

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Orissa	14	1·25	0·35	2·86
South-West Bengal	48	0·25	0·30	1·23
Central Provinces	24	0·23	0·27	1·47

15th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
False Point	29·722	—·043	SE	14	192
Cuttack	·695	—·072	E	4	167
Sambalpur	·642	—·095	E	6	[illegible]
Raipur	·617	—·137	N	10	196
Nagpur	·672	—·104	NW	2	46
Vizagapatam	·692	—·071	W	5	227

The depression had advanced during the preceding day across the Ganjam coast in a west-north-west direction, and its centre was, at 10 A.M. of the 15th, in the eastern districts of the Central Provinces, in the neighbourhood of Raipur. The depression was

as on the previous day, small, and was almost certainly less than two-tenths of an inch. The winds were of moderate force round the vortex, nowhere exceeding double their normal strength, except at Vizagapatam. The rainfall in connection with it at this time was not excessive in amount. It was heaviest in Orissa and the Central Provinces, but the average fall for the 24 hours preceding 6 P.M. was only one inch.

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Orissa	14	1·00	0·35	4·02
Chutia Nagpur	9	0·63	0·26	1·85
South-West Bengal	48	0·35	0·30	1·64
Central Provinces	24	0·81	0·27	2·72

16th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Nagpur	29·613	—·163	SW	4	89
Seoni	·585	—·183	SE	5	132
Jubbulpore	·611	—·152	S	8	216
Saugor	·600	—·149	E	3	103
Hoshangabad	·598	—·180	NE	2	67
Amraoti	·627	—·171	WNW	6	143

The results of the observations given above for the 16th September indicate that the whirl had advanced to the north-west, and that its centre was now in the north-west of the Central Provinces, some little distance to the north-west of Seoni and nearly midway between that station and Hoshangabad. The differences between the barometric observations of the morning and the normal pressure of the month for the same stations appear to indicate that the depression was slightly greater than on the previous day. It, however, almost certainly did not exceed a quarter of an inch. The wind averages for the previous 24 hours indicate that the circulation about the cyclonic vortex was very feeble, and very little stronger than the ordinary circulation of the season, except at Jubbulpore.

The rainfall for the previous 24 hours was also less in amount in the Central Provinces, but it was now extending to the adjacent districts of the North-Western Provinces, where it was, however, as yet very moderate.

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfal during previous 24 hours.
Orissa	14	0·26	0·35	0·76
Central Provinces	24	0·80	0·27	3·00
Central India	15	1·20	0 24	4·76
North-Western Provinces	42	0·11	0·20	0·80

17th September.

Station.	Bar meter, 10 A.M., reduced to sea level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as percentage.
Khandwa	29·668	—·122	W	8	135
Hoshangabad	·642	—·140	SW	5	167
Saugor	·681	—·068	SE	2	65
Agra	·624	—·120	SE	8	203
Ajmere	·621	—·132	NE	6	118
Indore	·597	—·207	NW	7	131

The central depression or vortex of the storm continued to advance in a north-west direction during the past 24 hours, and was at 10 A.M. of the 17th in Central India in Lat. 25° North and Long. 76° East. It had thus travelled through about 250 miles during the past 24 hours, or at the rate of 10 miles per hour. It continued to present generally the same features as before of a shallow depression, probably not exceeding a quarter of an inch at the centre, with winds of moderate force, not much stronger than the ordinary winds of the month. The winds were strongest at Agra, which occupied the same position with respect to the depression as Jubbulpore on the 16th. The rainfall connected with it had increased very considerably. It was heaviest in Central India, and in the west and north-west districts of the North-Western Provinces, and more especially in the Rohilkhand and Meerut divisions, in which it was abnormally excessive. The average fall over Central India, for the 24 hours preceding 6 P.M., was 1·28 inches, and over the North-Western Provinces 2·13 inches. The character of the rainfall in the North-Western Provinces is more fully shown by the following returns of the heaviest rainfalls during the previous 24 hours:—

	Inches.
Muzaffarnagar	12·90
Bijnor	12·40
Roorkee	11·21
Naini Tal	9·00
Saharanpore	6·00
Almora	5·80

The following table gives average rainfall data of the previous 24 hours:—

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Central Provinces	24	0·40	0·27	1·52
Central India	14	1·28	0·24	4·15
Rajputana	21	0·80	0·17	4·45
North-Western Provinces	42	2·13	0·20	12·90

18th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Jhansi	29·63⅓	—·094	SW	5	142
Lucknow	·656	—·080	SE	3	107
Bareilly	·592	—·138	E	3	106
Delhi	·604	—·124	NE	5	109
Ajmere	·692	—·061	NW	7	146
Agra	·531	—·213	SW	5	123

The observations indicate that the centre of barometric depression had advanced during the previous day to the north-east into the North-Western Provinces, and that it was to the north of Agra, and probably in the immediate neighbourhood of that station. The central depression probably did not exceed quarter of an inch, and the winds round it were, as hitherto, very little stronger than the normal winds of the month. At this time the disturbance was giving excessively heavy rainfall over the whole of the western and north-western districts of the North-Western Provinces, and more especially in the Rohilkhand, Meerut, and Agra divisions, and in the hill districts of Kumaun and Garhwal. Heavy rain had ceased to fall in Central India and Rajputana.

	Number of stations.	Average rainfall of previous 24 hours.	Average daily rainfall, September.	Heaviest rainfall during previous 24 hours.
Central India	14	0·16	0·24	1·10
Rajputana	21	0·21	0·17	3·55
North-Western Provinces	42	2·48	0·20	32·40

The following table gives the heaviest rainfall and the average rainfall in each district of the North-Western Provinces during the preceding 24 hours :—

Division.	District.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Meerut	Dehra Dun	6	3·97	6·00
	Saharanpore	8	5·29	19·50
	Muzaffarnagar	6	4·61	14·60

Division.	District.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Meerut (*contd.*)	Meerut	6	7·90	15·50
	Bulandshahr	6	2·35	6·00
	Aligarh	7	1·50	3·00
Rohilkhand	Bijnor	5	22·96	32·40
	Moradabad	6	6·67	9·30
	Pilibhit	5	3·96	5·40
	Bareilly	7	2·30	3·10
	Budaun	5	1·32	2·70
	Shahjahanpur	4	1·45	2·10
Agra	Muttra	6	1·32	3·60
	Agra	8	0·72	1·90
	Mainpuri	7	1·18	2·40
	Farukhabad	8	0·48	0·90
	Etawah	5	0·20	0·40
	Etah	4	1·58	3·60
Allahabad	Cawnpur	9	0·04	0·30
	Fatehpur	6	0·30	0·60
	Banda	8	0·18	0·60
	Allahabad	9	0·02	0·10
	Hamirpur	6	0·03	0·20
	Jaunpur	5	0·02	0·10
Benares	Azamgarh	5	.....	.....
	Mirzapur	5	0·18	0·50
	Benares	3	0·03	0·10
	Gorakhpur	6	.....	.....
	Basti	5	.....	.....
	Ghazipur	4	.....	.....
Jhansi	Jalaun	5	0·02	0·10
	Jhansi	7	0·19	0·40
	Lalitpur	4	0·10	0·40
Kumaun	Kumaun	6	9·65	13·00
	Garhwal	2	7·25	7·50
	Tarai	4	7·90	10·10

The observations of the 19th show that there was no longer any well-defined cyclonic circulation in Upper India. Hence the cyclonic vortex broke up on the afternoon or evening of the 18th, with the cessation of the heavy rainfall. The following gives the

average and heaviest rainfall of the 24 hours preceding 6 P.M., of the 19th in each district of the North-Western Provinces:—

Division.	District.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Meerut	Dehra Dun	6	0·11	0·36
	Saharanpur	8	0·10	0·30
	Muzaffarnagar	6	1·10	6·30
	Meerut	6	0·04	0·20
	Bulandshahr	6	.....	.....
	Aligarh	7	.....	.....
Rohilkhand	Bijnor	5	0·14	0·30
	Moradabad	6	0·15	0·70
	Pilibhit	5	1·04	2·70
	Bareilly	7	0·20	0·90
	Budaun	5	0·04	0·20
	Shahjahanpur	4	0·98	3·00
Agra	Muttra	6	.....	.....
	Agra	8	.....	.....
	Mainpuri	7	0·20	1·00
	Farukhabad	8	0·03	0·20
	Etawah	5	.....	.....
	Etah	4	0·08	0·30
Allahabad	Cawnpore	9	.....	.....
	Fatehpur	6	.....	.....
	Banda	8	.....	.....
	Allahabad	9	.....	.....
	Hamirpur	6	.....	.....
	Jaunpur	5	0·10	0·50
Benares	Azamgarh	5	0·02	0·10
	Mirzapur	5	.....	.....
	Benares	3	0·07	0·20
	Gorakhpur	6	1·37	3·60
	Basti	5	1·46	2·30
	Ghazipur	4	.....	.....
Jhansi	Jalaun	5	.....	.....
	Jhansi	7	.....	.....
	Lalitpur	4	.....	.....
Kumaun	Kumaun	6	2·32	5·20
	Garhwal	2	1·05	1·50
	Tarai	4	0·88	1·40

The storm under discussion is one of the most remarkable that occurred during the quinquennial period 1877-81. The following data determine the path of the vortex:—

Date.	Position of centre.		Distance passed over in preceding 24 hours.	Average rate of motion in miles per hour during previous 24 hours.
	Latitude.	Longitude.		
13th September	18° 45′ N.	88° 30′ E.	...	...
14th „	19° 30 N.	85° 30′ E.	210	9
15th „	20° 30′ N.	82° 30′ E.	210	9
16th „	22° 45′ N.	79° 15′ E.	250	10
17th „	25° 0′ N.	76° 0′ E.	250	10
18th „	27° 30′ N.	78° 0′ E.	210	9

The following are a few of the more remarkable features of the storm:—

1st.—It was a comparatively small disturbance at sea, and for some time after it crossed the coast.

2nd.—It intensified considerably in the interior of the country, whilst advancing through Rajputana into the North-West Provinces.

3rd.—The rainfall that accompanied its existence was excessive over a large portion of the western half of the North-West Provinces and apparently fell at some distance to the north of the centre. The character of the rainfall is shown very fully by the amounts registered in the five districts of Bijnor, Meerut, Muzaffarnagar, Saharanpore and Kumaon, given below:—

District.	Station.	17th.	18th.	19th.	Total.
Saharanpore	Roorkee	10·70	8·00	0·20	18·90
	Hardwar	...	19·50	...	19·50
Muzaffarnagar	Muzaffarnagar	12·90	4·20	0·20	17·30
	Jaoli Jánsath	16·00	14·60	...	30·60
Meerut	Mawana	...	15·50	...	15·50
Bijnor	Nagina	...	32·40	0·20	32·60
	Dhampur	...	30·40	0·20	30·60
	Najibabad	...	28·50	0·30	28·80
Kumaun	Champawat	...	13·00	5·20	18·20
	Ranikhet	2·30	12·00	2·90	17·20

4th.—A striking feature was the extreme lightness of the winds over the area of cyclonic circulation in the interior of the country. The winds, so far as can be judged from the whole of the observations, appear to have been little stronger than the average of the month, and probably were not above 10 miles per hour in any portion of the circulation.

(*No. XXXIII.*)—*Storm of September 21st to the 26th.*—This storm was of little importance. It was a very feeble whirl, and gave very moderate rain to the districts

over which it passed. The meteorological returns on the 20th of September show that there was a slight tendency to lower barometer at Chittagong, and the adjacent part of the Bay, than over the remainder of the Bay. The winds at the neighbouring stations were somewhat irregular; but, on the whole, indicated the commencement of feeble cyclonic indraught. The returns for the 21st of September of the stations nearest the central depression are as follows:—

21st September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Diamond Island	29·771	—·087	SSW	12	171
Akyab	·699	—·135	SE	3	103
Chittagong	·671	—·143	ENE	3	64
Saugor Island	·680	—·073	N	6	64
False Point	·682	—·083	N	6	86
Vizagapatam	·736	—·022	WNW	2	87

The observations indicate that general cyclonic circulation was established over the head of the Bay. The barometric depression, as measured by the variation from the normal, was greatest in the neighbourhood of the Chittagong coast. The centre was probably in the central portion of the head of the Bay, and was travelling westwards. The winds round the coast were very feeble, and generally below their normal strength. The character of the rainfall at this time is shown by the following:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during past 24 hours.
Burmah	15	2·00	6·32
East Bengal	24	0·53	2·50
South-West Bengal	48	0·21	3 44
Orissa	14	0·83	3·60

22nd September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Chittagong	29·690	—·078	W	2	77
Saugor Island	·674	—·079	SSW	4	43
False Point	·591	—·174	S	7	100
Vizagapatam	·761	+·003	WNW	1	43

The returns for the 22nd appear to indicate that the central depression crossed the Orissa coast between False Point and Balasore shortly before 10 A.M. The depression was small, probably not exceeding two-tenths of an inch. Moderately heavy rain was falling, but the centre was by no means clearly marked, nor the circulation in the neighbourhood distinctly cyclonic. The above returns show that the winds were very feeble near the central depression. The following table gives the distribution of the rainfall of the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during past 24 hours.
Burmah	12	1·04	2·67
Arakan	3	1·65	2·00
South-West Bengal	48	1·10	3·90
Orissa	14	0·82	2·70

23rd September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction, at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Akyab	29 730	—·104	SE	10	340
Calcutta	·598	—·157	ENE	5	106
Saugor Island	·572	—·181	E	4	43
False Point	·596	—·169	W	8	143
Vizagapatam	·737	—·027	WNW	3	125

The returns for this day indicate the existence of a centre in the north-west angle of the Bay between Saugor Island and False Point, and probably almost due south of the former station. The returns for the 22nd clearly point to the existence of a somewhat badly defined and feeble whirl which had crossed the coast on the morning of that day. This was hence apparently another whirl, following in the rear of the previous, and part of the same general disturbance. It was better defined and more fully developed than the previous. The depression at the nearest station, Saugor Island, was ·18″. Hence the central depression probably did not exceed a quarter of an inch. The winds were of moderate force, except in the eastern quadrant, where they were unusually strong. The following gives the distribution of the rainfall of the previous 24 hours :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during past 24 hours.
East Bengal	24	0·50	2·28
South-West Bengal	48	0·80	9·90
Orissa	14	0·61	2·00
Chutia Nagpur	9	0·96	2·17

24th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Saugor Island	29·704	—·049	SSE	12	128
Calcutta	·717	—·040	SE	10	193
Burdwan	·716	—·050	E	7	206
Hazaribagh	·680	—·074	E	14	203
Sutna	·718	—·025	NE	9	140
Seoni	·773	+·006	NW	4	105
Raipur	·703	—·044	W	13	241
Sambalpur	·607	—·130	SW	7	350

The preceding observations show that the whirl was in the immediate neighbourhood, and to the west, of Sambalpur. The cyclonic winds feeding it were about double the normal September strength, but were nowhere violent. The rainfall at this time was moderate in amount. The distribution of the rainfall is shown by the following :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during past 24 hours.
South-West Bengal	48	0·21	1.41
Orissa	14	0·31	2·50
Chutia Nagpur	9	0·30	0·80
Central Provinces	24	0·30	2·30

25th September.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.		
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.
Raipur	29·693	—·054	NE	13	260
Sambalpur	·755	+·018	E	1	50
Hazaribagh	·771	+·017	E	14	203
Jubbulpore	·690	—·080	NE	4	105
Nagpur	·721	—·054	N	6	136
Vizagapatam	·766	+·008	W	3	126
False Point	·786	+·021	S	5	71
Saugor Island	·795	+·042	SE	9	96

The central depression was near Raipur. The depression was now filling up rapidly and the rainfall was small in amount. The winds had fallen at 10 A.M. to their normal strength of the season. The distribution of rainfall is given in the following table:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·08	0·76
Central Provinces	24	0·58	2·57
South-West Bengal	48	0·05	0·46
Chutia Nagpur	9	0·08	0·35

There was no definite cyclonic circulation on the 26th, and the rainfall was very scanty. It hence probably disappeared during the evening of the 25th.

The following are the only characteristics of the storm that deserve notice:—

1st.—The storm was a very small one, both in extent and intensity, and yet it crossed the Orissa hills into the Central Provinces, where it however did not give rise to heavy rainfall, and it consequently filled up after advancing as far as Raipur. This was evidently due to the fact that the Bombay monsoon current was no longer in force, and was backing down the Malabar coast.

2nd.—The one remarkable feature is that the disturbance consisted of two small whirls, the second of which followed rapidly behind the first, and was the larger, and longer-lived, of the two.

(*No. XXXIV.*)—*Storm of October 12th to the 15th.*—This was a small storm of somewhat unusual character which formed at the commencement of the north-east monsoon. The south-west monsoon retreated from Bengal during the first week of October, and commenced to recurve over the north of the Bay. A small disturbance formed in front of the recurved current near the Vizagapatam coast. It crossed the coast, and, unlike October cyclones generally, advanced across the hills into the Central Provinces, where it shortly afterwards broke up. The southerly winds in the eastern quadrant marched northwards, and obtained possession of the head of the Bay and gave very heavy rain to the coast of Orissa and the Sunderbunds for a brief period.

12th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·935	+·008	WSW	5	72	1·22
Diamond Island	·965	+·042	E	11	164	0·97
Akyab	·964	+·050	ENE	2	87	0·02
False Point	·909	0	ENE	9	158	0·07
Vizagapatam	·884	—·014	N	2	95	0·20
Masulipatam	·896	—·014	NNE	?	?	*Nil.*
Madras	·908	—·002	N	4	78	*Nil.*

The observations of the 12th showed that a depression was commencing to form in the centre of the Bay, and that pressure was lowest on the midwest coast between Masulipatam and Vizagapatam. Moderate winds obtained generally. The wind directions at Port Blair (WSW.), and Diamond Island (E.) prove that the south-west monsoon current was recurving over the centre of the Bay. As the observations also establish that light north-easterly winds prevailed on the Coromandel coast, it is evident that the recurved south-west current was not advancing in force towards that coast.

The following gives the average rainfall in Bengal at this time:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	48	0·13	1·54
North Bengal	31	0·10	1·02
East Bengal	24	0·01	0·11

A few light local showers were received in Bengal at this time, but they were of no importance, and the weather was generally fine and clear.

Moderately heavy rain was falling on the Ganjam coast, and light showers over the greater part of the Madras presidency. The following table gives the chief rainfalls in that area—

Station.	Rainfall in previous 24 hours.	Station.	Rainfall in previous 24 hours.
Ganjam	4·30	Bimlipatam	0·65
Gopalpore	4·96	Vizagapatam	0·40
Aska	2·00	Rajahmundry	0·80
Vizianagram	1·00	Vriddachalam	1·00

13th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·935	+·008	ESE	4	58	*Nil.*
Diamond Island	·910	—·013	SE	1	15	0·11
Akyab	·920	+·006	NE	3	130	0·04
False Point	·872	—·037	E	11	193	4·99
Vizagapatam	·729	—·169	N	4	190	1 60
Masulipatam	·812	—·098	NNE	?	?	*Nil.*
Madras	·859	—·051	W	4	78	*Nil.*

The depression had intensified considerably during the preceding 24 hours, and was approaching the coast between Vizagapatam and Coconada. Winds had shifted round to

west on the Coromandel coast, and indicated that cyclonic circulation was now fully established. The depression was evidently a small one, as the winds at Port Blair and Diamond Island were remarkably feeble. Light showers fell in Bengal during the previous 24 hours, and heavy rain in Orissa, Ganjam, and the Northern Circars.

The following gives the average rainfall of the preceding 24 hours in Bengal and Orissa:—

	Number of stations.	Average rainfall during previous 24 hours.	Heaviest rainfall of previous 24 hours.
South-West Bengal	48	0·52	2·46
North Bengal	31	0·13	1·10
East Bengal	24	0·46	3·04
Orissa	14	1·34	4·78

The following gives the largest rainfalls in the eastern and northern districts of the Madras Presidency, and establishes that heavy rain was falling in Ganjam and the Northern Circars:—

Station.	Rainfall in previous 24 hours.	Station.	Rainfall in previous 24 hours.
Gopalpore	6·52	Salem	1·56
Vizianagram	5·10	Saidapet	0·17
Vizagapatam	3·90	Udayarpalaiyam	0·48
Bimlipatam	3·70	Atur	0·20
Ganjam	2·00	Tranquebar	0·95
Coconada	1·45	Tanjore	0·35

14th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·892	—·035	E	6	87	*Nil.*
Diamond Island	·892	—·031	ENE	3	45	*Nil.*
Akyab	·891	—·023	E	4	174	0·15
False Point	·840	—·069	N	8	140	0·78
Vizagapatam	·702	—·196	SSW	10	476	5·00
Masulipatam	·763	—·147	NNE	?	?	*Nil.*
Madras	·808	—·102	WNW	4	78	*Nil.*

The centre of the depression crossed the coast a few miles to the south of Vizagapatam on the morning of the 14th, and was about 20 miles to the west of Vizagapatam at

10 A.M. The depression at the centre was small, not exceeding a quarter of an inch. The disturbance was of small extent and intensity, but was accompanied by strong winds near the centre, as is proved by the Vizagapatam observations.

The following table gives the average rainfall of the previous 24 hours in Bengal :—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	48	0·32	1·42
North Bengal	31	0·09	0·66
East Bengal	24	0·72	1·89
Orissa	14	0·86	2·40

The rainfall in Madras was not large in amount. The heaviest falls were received in Ganjam and the Circars, and are given in the following statement :—

Station.	Rainfall in previous 24 hours.	Station.	Rainfall in previous 24 hours.
Ganjam	1·00	Madras	0·31
Gopalpore	1·82	Tindivanum	1·80
Aska	1·50	Cuddalore	0·83
Vizianagram	0·50	Vriddachalam	4·00
Bimlipatam	0·20	Udayarpalaiyam	0·42
Vizagapatam	2·50	Salem	0·05
Coconada	0·55	Atur	1·85

15th October.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·883	—·044	ENE	5	72	0·12
Diamond Island	·876	—·047	NE	4	60	*Nil.*
Akyab	·900	—·014	NE	3	130	*Nil.*
Chittagong	·893	—·028	Calm	2	62	0·09
Saugor Island	·905	+·007	E	8	129	8·40
False Point	·842	—·067	SE	6	105	2·52
Cuttack	·823	—·090	NE	4	222	0·76
Vizagapatam	·793	—·105	W	2	95	0·30
Masulipatam	·795	—·115	SW	?	?	*Nil.*
Madras	·827	—·083	WSW	3	59	0·31
Sambalpur	·800	—·095	E	1	50	0·81
Raipur	·793	—·125	NE	8	200	0·13
Sironcha	·828	—·115	NW	6	200	...

The depression had advanced in a north-westward direction during the previous 24 hours across the Eastern Ghats into the south-eastern districts of the Central Provinces. The cyclonic circulation was somewhat irregular, but was still clearly marked. The centre of the circulation was in about Lat. 19° 30′ North and Long. 82° East. The chief feature at this time was the advance of strong moist winds to the head of the Bay, which gave unusually heavy rain to the coast area from Saugor Island to Gopalpur. Saugor Island received 8·4 inches during the previous 24 hours.

The following gives the average rainfall of the previous 24 hours in Bengal and Orissa:—

	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	48	0·87	8·40
North Bengal	31	0·23	2·10
East Bengal	24	0·36	1·49
Orissa	14	1·06	3·04

The rainfall in the Madras Presidency was much smaller in amount than on the 14th. The only amounts exceeding one inch were Gopalpur 1·6 inches, Aska one inch, and Trichinopoly 1·12 inches.

The observations of the 16th show that the disturbance had completely disappeared, and that fine weather and clear skies prevailed over Bengal and the head of the Bay.

The chief features of the disturbance were—

1st.—Its unusual line of motion, across the Eastern Ghats. The October cyclones are in ordinary seasons formed during the transitional period, and are of low elevation. The present storm was formed early in October, after a stronger south-west monsoon than usual, and hence presented the characteristics of a storm of the rains rather than of the transitional periods.

2nd.—Its rapid disintegration in the Central Provinces, due to the absence of a strong moisture current from the west. The Bengal current gave heavy rainfall to the coast area, but failed to supply it to the distant vortex after it crossed the Eastern Ghats. It is a striking corroboration of the assumption that cyclonic vortices that have crossed the Orissa hills and march further westwards are maintained and fed mainly, if not entirely, by the Bombay monsoon current.

(*No. XXXV.*)—*Storm of November 19th to the 22nd.*—This was a very small storm in extent, and formed very rapidly. It was characterized by an unusually large depression. It was generated to the north-east of the Ceylon coast, and marched westwards, striking the south Madras Coast near Negapatam.

The following observations taken at 10 A.M. on the 18th at the land stations on the east and west coasts of the Bay show that north-east monsoon winds were established over the greater part of the Bay. They give no indication of the establishment of cyclonic circulation at that time in the Bay.

18th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·977	+·017	ESE	13	240	1·27
Port Blair	·994	+·036	NE	8	110	...
Diamond Island	30·046	+·079	NE	10	120	...
Vizagapatam	·088	+·067	N	2	80	...
Masulipatam	·072	+·064	NNE	?	?	...
Madras	·059	+·068	NNE	3	44	0·13
Negapatam	·016	+·051	NNE	6	107	0·51
Colombo	29·979	+·030	NNW	5	93	0·09
Galle	·973	+·034	NE	2	59	...

The wind direction at Nancowry proves that the south-west monsoon was not completely displaced from the Bay, although north-easterly winds prevailed as far south as Port Blair. Strong winds from the east-south-east were blowing at Nancowry and giving heavy rain. Hence it is almost certain that the south-west winds were recurving near the entrance to the Bay, and that rain was falling over the eastern and central portions of that area. No rain was received in Bengal or Burmah during the preceding 24 hours, and only one or two very light showers of no importance in the Madras Presidency.

19th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	30·006	+·046	E	9	167	0·54
Port Blair	29·998	+·040	NE	12	164	...
Diamond Island	30·064	+·097	NE	7	84	...
Vizagapatam	·084	+·063	NE	2	80	...
Masulipatam	·061	+·053	NNE	?	?	...
Madras	·031	+·040	NNE	7	103	...
Negapatam	·005	+·040	NNE	8	143	...
Colombo	29·963	+·014	NE	7	130	...
Galle	·954	+·015	Calm	2	59	...

No change of importance occurred during the previous 24 hours, except a slight change in the wind direction at Nancowry from east-south-east to east, a moderate increase in the force of the wind at Port Blair, and a considerable decrease at Diamond Island. No rain fell in Bengal or Burmah, nor in the Madras Presidency, except light showers at one or two of the hill stations. Normal gradients were established over the Bay, so far as is indicated by the land observations.

20th November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·983	+·023	ESE	7	130	·23
Port Blair	·983	+·025	NE	13	178	...
Diamond Island	30·046	+·079	ENE	11	132	...
Vizagapatam	·020	—·001	NE	2	80	...
Masulipatam	29·999	—·009	NE	?	?	...
Madras	·957	—·034	N	7	103	0·03
Negapatam	·910	—·055	NNE	8	143	0·15
Colombo	·905	—·044	NNW	9	167	...
Galle	·891	—·048	NW	6	176	0·02

The observations at the Coromandel coast stations indicate the approach of the depression which had formed during the previous 48 hours. The barometer had fallen a tenth of an inch at these stations, winds were shifting round from north-east through north to north-west, and increasing rapidly in force, whilst rain was commencing to fall. The centre was to the east-south-east of Negapatam at 10 A.M., and probably in Lat. 9° 45′ North and Long. 81° 45′ East. No rain fell in Burmah or Bengal during the previous 24 hours. Considerable amounts were received on the coast districts between Negapatam and Madras. The following amounts exceeding 1 inch were registered at 6 P.M.:—

1. Ganjam Coast—

	Inches.
Ganjam	2·40
Gopalpur	2·78

2. Coromandel Coast—

	Inches.
Nellore	1·65
Madras	1·14
Cuddalore	1·50

3. Coromandel Coast Districts—

	Inches.
Combaconum	2·20
Tanjore	6·00

21st November.

Station.	Barometer, 10 A.M., reduced, to sea-level.	Difference from normal.	Wind. Direction at 10 A.M.	Wind. Velocity in miles per hour for preceding 24 hours.	Wind. Ratio of amount of wind to average amount expressed as a percentage.	Rainfall in previous 24 hours.
Madras	29·862	—·129	ESE	12	177	1·18
Bangalore	·863	—·123	NNE	2	57	...
Salem	·859	—·147	N	2	57	0·04
Coimbatore	·860	—·130	SSE	1	37	...
Madura	·882	—·082	SW	5	122	...
Trichinopoly	·794	—·195	WSW	4	87	1·24
Negapatam	·298	—·667	NE	20	357	8·10
Colombo	·885	—·064	NNE	5	93	0·84
Trincomalee	·862	—·089	S	?	?	5·93
Galle	·877	—·062	W	7	206	0·64

The observations show that the centre of a very deep depression was approaching the coast near Negapatam. The storm was of very small extent, as Trincomalee and Madras were both nearly, if not quite, beyond its limits. The barometer had fallen six-tenths of an inch at Negapatam during the preceding 24 hours, and gradients in the neighbourhood were very steep. The lightness of the winds in the outer portions of the western quadrant (as, for example, at Trichinopoly and Salem) is remarkable. The storm crossed the coast shortly after 10 A.M., a few miles to the south of Negapatam.

Rain fell over a very large portion of the Madras Presidency. It was only heavy in the small area covered by the cyclone, or in the Tanjore, Trichinopoly, Arcot, and Salem districts. All the known rainfalls exceeding 2 inches registered for the previous 24 hours in the Madras Presidency are given in the following table, and show that heavy rain was confined to the central area of depression :—

Tanjore District.	Inches.	Trichinopoly District.	Inches.	Salem District.	Inches.
Negapatam	8·1	Trichinopoly	3·76	Atur	8·4
Combaconum	4·9	Udayarpalaiyan	2·8	Shevaroy Hills	6·0
Tranquebar	4·7				
Tanjor	2·5				

South Arcot.	Inches.	North Arcot.	Inches.	Coimbatore.	Inches.
Vreddachalum	2·50	Arcot	4·50	Karur	2·08
Cuddalore	2·15				

22nd November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Madras	29·979	—·012	SSE	12	177	0·27
Bangalore	962	—·024	NE	8	229	0·86
Mercara	·933	—·005	WNW	8	110	0·06
Salem	·968	—·038	E	7	200	4·61
Coimbatore	·911	—·079	S	1	37	0·09
Madura	·906	—·058	NNW	3	73	0·22
Trichinopoly	·952	—·037	ESE	2	44	3·65
Negapatam	·945	—·020	SSE	2	36	...
Colombo	·943	—·006	SSW	9	167	0·02
Trincomalee	·947	—·004	SE	8	119	0·43
Galle	·946	+·007	?	?	?	...

The preceding observations establish that the depression had almost disappeared. The winds were irregular in direction, and do not show any definite cyclonic circulation. The disturbance had thus probably been completely broken up by the action of the Shevaroy, Palni, and other hills in this part of India which attain an elevation of 6,000 to 8,000 feet in their highest points. The most remarkable feature of the meteorology of the 23rd (one which usually occurs immediately after the disintegration of a cyclonic vortex by the obstructive action of hills) was the extreme lightness of the winds in South-Eastern India. The wind directions at Negapatam, Trichinopoly, Salem, and Madura indicate light irregular cyclonic circulation, which passed away before the morning of the 23rd.

The following table gives rainfalls exceeding 2 inches which occurred during the previous 24 hours in the Madras Presidency. It shows, that the rainfall was much more irregular in its distribution than it was on the 21st, and that the largest amounts were received in the south-eastern and southern parts of the Presidency.

	Inches.		Inches.
Vellore	7·10	Conjevaram	3·30
Palmanai	5·80	Cuddalore	3·00
Tindivanum	5·00	Ongole	2·65
Chittore	4·76	Vriddachalum	2·60
Udayarpalaiyam	4·70	Tinnevelly	2·15
Vizagapatam	3·90	Salem	2·06

23rd November.

Station.	Barometer, 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Madras	30·023	+·032	ESE	4	59	0·75
Bangalore	29·988	+·002	E	6	171	0·33
Salem	30·030	+·024	NE	8	229	0·30
Coimbatore	·030	+·040	NE	3	111	0·09
Madura	·041	+·077	NW	4	98	0·12
Trichinopoly	·040	+·051	NE	3	65	0·05
Negapatam	·005	+·040	S	4	71	0·71
Colombo	29·975	+·026	N	6	111	...
Trincomalee	·995	+·044	NE	21	313	...
Galle	·965	+·026	ESE	3	88	...

The observations of the 23rd are given to show that the disturbance had been completely dispersed during the preceding 24 hours. The winds had reverted to their normal November directions and strength; the barometer was considerably above the normal, and skies were clearing. Little or no rain fell for some days afterwards. The Trincomalee observations also prove that north-east winds were again established over the south-west of the Bay. Showers occurred during the preceding 24 hours throughout the Province, but the only rainfalls exceeding one inch were 3·35 inches at Nellore, on the coast to the north of Madras, and 1·28 inches at Madras.

The more remarkable features of the storm were:—

1st.—The very small area which it covered, and the unusually large depression of the barometer at the centre, which was probably not much less than one inch. The storm area proper was almost certainly less than 150 miles in diameter.

2nd.—The large rainfall which occurred at stations near the path of the centre. The following are the most remarkable:—

Station.	Rainfall.				
	19th.	20th.	21st.	22nd.	Total.
Tranquebar	...	...	4·70	0·50	5·20
Coimbaconum	...	2·20	4·90	1·05	8·15
Cuddalore	...	1·50	2·15	3·00	6·65
Tindivanum	...	...	1·50	5·00	6·50
Conjeveram	...	...	1·50	3·30	4·80
Atur	0·10	0·30	8·40	0·35	9·15
Udayarpalaiyam	...	...	2·80	4·70	7·50
Tanjore	...	6·00	2·50	0·25	8·75
Trichinopoly	...	...	3·76	1·13	4·89
Negapatam	...	0·15	8·10	...	8·25

It is probable that the rainfall at sea was even larger in amount, and that the excessive and local character of the rainfall determined the peculiar features of the storm.

3rd.—The rapidity with which the storm, although a very intense one, was broken up by the high hills of Southern India after it crossed the coast. The storm does not appear to have continued as a well-defined circulation for more than six or eight hours after it passed Negapatam.

The following are the chief characteristics of the distribution of the storms of 1880 :—

1st.—No storm originated during the May transition period, with the exception of a small storm at the head of the Bay which formed on the last day of the month and belongs rather to the intermediate period.

2nd.—The coast to the west of the mouth of the Hooghly was free from storms during the whole monsoon period.

3rd.—A succession of seven storms formed during the intermediate period and passed across the Orissa coast. The chief feature of these storms as contrasted with the storms of the same period in 1879 was that they were initiated in the neighbourhood of the west coast and at a much greater distance from the Aracan coast than in 1877.

4th.—There was a marked tendency in these storms which passed across the Orissa coast into the Central Provinces to pass to a less distance west than usual and to break up in Rajputana or the adjacent districts of the North-Western Provinces. In this respect 1880 resembled to a considerable degree the year 1879. Not one storm passed from the head of the Bay into Sindh or North Bombay during the whole south-west monsoon period.

5th.—Two storms occurred during the October or cold-weather transition period. The latter, that of November 19th to 22nd, although a small one, was marked by the greatest depression of the barometer of all the storms during the period 1877 to 1881.

6th.—The storm of September 12th to 19th accompanied one of the heaviest and most general bursts of cyclonic rainfall on the plains of Northern India that have occurred during recent years.

1881.

The year 1881 was characterized by less strongly marked pressure variations than the year 1880. January and February were unusually dry months. The cold-weather rains failed almost entirely in Upper India. Temperature was hence slightly above the normal in January. It increased rapidly in February, and the average temperature of the month was above the average over the whole of Northern India. The excess in the Punjab for the month was 5°. A considerable amount of rain fell in March during a brief period of disturbance in Northern India which reduced the average temperature of the month from ½° to 4° below the mean of the month. The meteorology of the two months of April and May varied much less from the normal. The variations of the mean temperature were small, and frequent thunder showers occurred in Bengal, and occasional dust storms in Upper India. The pressure variations during these two months antecedent to the rains were insignificant. The mean pressure of the whole of

India was almost identical with the normal mean. Pressure, relatively to the normal or average distribution, was slightly in defect in Bengal, Assam, Orissa, Aracan, and Pegu; and in excess, to a small extent, in the Gangetic plain, Rajputana, Central India, and the northern districts of the Central Provinces and Bombay.

The south-west monsoon set in at the commencement of June slightly earlier than usual. The monsoon rains fell steadily and abundantly in Burmah, Aracan, and on the Bengal coast districts during the month. The Bombay rains did not prevail in force until the beginning of July. The full establishment of both branches of the monsoon currents gave abundant rain during that month over the whole of India, excepting Oudh, the eastern districts of the North-West Provinces, Behar, North Bengal, and Assam. Average or abundant rain was received during August in almost every part of India. The rains terminated somewhat earlier than usual in Northern India, and hence the rainfall of the month of September was in defect over the Punjab, North-West Provinces, Central India, Behar, and the western districts of Bengal. It was excessive, on the other hand, in Eastern and Northern Bengal, Assam, Aracan, and Pegu.

October was an unusually dry month in Upper India. Bengal and Burmah generally received average rainfall. Pressure at the end of the rains was in defect over the whole of India. The deficiency was most marked along the east coast of the Bay in Tenasserim, Pegu, Aracan, South-West and East Bengal, Cachar, and Assam; and was least in the Deccan, Hyderabad, Carnatic, and Ceylon. The north-east monsoon set in very late and feebly on the Coromandel coast, and did not give general rain until the month of November. During that month, the greater part of Southern India and Ceylon received larger amounts of rain than usual.

(*No. XXXVI.*)—*Storm of May 26th to the 28th.*—This was a very small disturbance which formed near the head of the Bay in front of the first advance of monsoon winds, and passed across the coast of the Sunderbunds into Central Behar, where it speedily broke up.

The observations of the 25th at the Burmah and Aracan coast stations indicated that an advance of southerly winds was in progress up the Bay. Pressure was slightly below the normal, and winds were feeble and below their average strength in Bengal. They first gave indication by their directions of the existence of a whirl at the head of the Bay on the morning of the 26th. The following are the 10 A.M. observations of that day at the stations on the coast of the north of the Bay:—

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·857	—·008	SW	8	103	0·15
Diamond Island	·843	—·014	SE	13	206	0·05
Akyab	·790	—·032	SSW	7	206	0·10
Chittagong	·745	—·066	SE	6	92	0·15
Saugor Island	·627	—·120	NNE	7	48	2·23
False Point	·627	—·134	N	5	42	1·53
Vizagapatam	·692	—·079	W	1	26	0·20

The observations establish that there was a slight depression in the north-west angle of the Bay. Winds were strong on the Pegu and Aracan coasts, but were unusually feeble in South Bengal and Orissa. Rain was falling over the coast districts of the north of the Bay. It was moderately heavy in Bengal, as is shown by the following averages:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Burmah	17	0·11	0·62
East Bengal	24	1·15	4·40
South-West Bengal	48	0·94	7·90
North Bengal	31	1·19	4·47

27th May.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Akyab	29·782	—·040	SSE	7	206	0·64
Chittagong	·715	—·096	SE	8	123	0·26
Dacca	·610	—·163	S	8	127	0·21
Jessore	·555	—·223	NW	3	63	1·28
Berhampore	·591	—·169	N	5	91	0·05
Burdwan	·624	—·113	N	5	88	1·16
Calcutta	·614	—·120	WNW	3	41	0·58
Saugor Island	·664	—·083	WNW	14	97	3·85

The depression had advanced northwards into Central Bengal during the previous 24 hours. The centre at 10 A.M. was a few miles to the north of Jessore. Moderately strong winds prevailed in the eastern quadrant. The northerly winds in the western quadrant were, on the other hand, below their average strength. Moderately heavy rain fell over the whole of Bengal. The following table gives average amounts for the previous 24 hours in Bengal and Burmah:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Burmah	17	0·23	0·79
East Bengal	24	0·85	2·20
South-West Bengal	48	0·85	4·62
North Bengal	31	1·88	7·30

28th May

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Saugor Island	29·740	—·007	SSW	12	83	*Nl.*
Jessore	·735	—·043	WSW	2	42	0·06
Dacca	·736	—·037	SW	8	127	0·12
Silchar	·771	—·043	SE	4	114	0·10
Dhubri	·634	—·156	NE	15	P	1·67
Purneah	·747	+·013	E	3	86	*Nil.*
Hazaribagh	·665	—·025	WSW	8	94	*Nl.*

The depression had passed from Central into North Bengal, during the previous 24 hours. The disturbance was evidently breaking up. The barometric depression at the centre was smaller, and winds somewhat irregular. There was no definite centre of circulation. The depression was greatest at Dhubri, and it is hence probable that the vortex had moved almost due north into the Rungpore district, but was rapidly being disintegrated by the action of the neighbouring hills. The disturbance passed away before the morning of the 29th, when normal conditions were again established in Bengal. The following table gives the rainfall of the previous 24 hours:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Burmah	17	0·21	1·13
East Bengal	24	0·61	3·10
South-West Bengal	48	0·08	1·17
North Bengal	31	0·24	2·11

The rainfall of the 24 hours was much smaller than that of the 27th. Little or no rain fell in Bengal or Orissa on the 29th.

The only interesting feature of the present storm was its formation in front of an early and feeble advance of monsoon winds up the Bay.

(*Nos. XXXVII and XXXVIII.*)—*Storms of June 1st to the 9th.*—These two storms apparently belonged to the same general disturbance, and coincided with the advance of the south-west monsoon rains into Bengal. They formed in the front of the advancing current near the head of the Bay. The second of the two whirls crossed the Orissa coast and hills, and received an accession of force from the Bombay current. It gave very heavy rainfall in the Central Provinces, after which it filled up without passing beyond the limits of the Central Provinces. The observation of the 1st of June first indicated the existence of the first whirl.

1st June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·684	—·154	W	12	110	6·65
Diamond Island	·625	—·180	SSE	6	71	0·22
Akyab	·589	—·148	Calm	1	26	·001
Chittagong	·574	—·122	E	4	56	...
Saugor Island	·569	—·039	S	7	52	...
False Point	·542	—·095	E	7	68	...
Vizagapatam	·531	—·138	S	1	·26	...

The observations show that a very humid current was advancing up the Bay, which was giving heavy rain at the Andamans, and light showers on the Burmah and Aracan coasts. The wind directions at Port Blair and Diamond Island prove that there was a marked tendency to eddying motion near the front of the advancing current. Winds were unusually feeble at the head of the Bay and in South Bengal. Skies were clear and weather sultry in Bengal. A few local thunder showers occurred during the day, but the rainfall in Bengal, as shown by the averages of the following table, was very small in amount:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest fall in 24 hours preceding 6 P.M.
South-West Bengal	48	0·04	0·60
North Bengal	25	0·02	0·45
East Bengal	24	0·36	1·67

Rain was also commencing generally in Burmah. It was, however, confined to light passing showers, except in the Tenasserim Division, where heavy monsoon rain had begun to fall. Tavoy received 4·21 inches during the previous 24 hours, and Mergui 1·41 inches. The average amount of rain received by the 14 rainfall-reporting stations of Burmah was 1·15 inches.

2nd June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·705	—·133	SW	15	138	0·44
Diamond Island	·630	—·175	S	13	153	0·34
Akyab	·585	—·152	SE	4	103	0·54
Chittagong	·578	—·118	E	4	56	0·53
Calcutta	·593	—·014	ENE	3	48	0·50
Saugor Island	·546	—·062	E	4	30	0·37
False Point	·520	—·117	NE	5	48	0·02

A well-defined cyclonic circulation was now established over the head of the Bay, and the winds at the coast stations of Bengal and Orissa had shifted round in obedience to it during the previous 24 hours. Winds were increasing rapidly in strength in the eastern quadrant, but were very feeble in the northern and western quadrants. The rainfall of the preceding 24 hours was smaller in amount at the east coast stations. This was evidently due to the concentration of the disturbance at sea.

The humid winds accompanying the disturbance had begun to penetrate into East and South-West Bengal, over which area moderate general rain fell during the day. The following table gives the distribution of the rainfall at this time :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest fall in 24 hours preceding 6 P.M.
South-West Bengal	48	0·79	4·14
North Bengal	25	0·08	0·65
East Bengal	24	1·02	4·70
Burmah	14	1·05	2·85

3rd June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29 722	—·116	SW	13	120	1·30
Diamond Island	·675	—·130	SSE	17	200	0·45
Akyab	·570	—·167	SSW	8	205	1·65
Chittagong	·538	—·158	ESE	5	70	1·30
Dacca	·516	—·128	NE	5	63	0·17
Calcutta	·477	—·130	ENE	4	63	1·41
Saugor Island	·469	—·139	NNE	8	60	0·40
False Point	·495	—·142	NNW	9	87	0·01

The depression had intensified considerably during the previous day, and the centre was advancing apparently in a westerly or west-north-westerly direction across the head of the Bay towards the North Orissa coast. The southerly humid winds in the eastern quadrant continued to increase in force. The winds in Bengal and Orissa were still considerably below the normal strength. Moderately heavy rain continued to fall in Burmah and East Bengal, but in West Bengal and Orissa the amounts registered were as yet small. The following table gives the distribution of the rainfall:—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest fall in 24 hours preceding 6 P.M.
Orissa	14	0·45	3·32
South-West Bengal	48	0·20	1·00
North Bengal	25	0·27	1·50
East Bengal	24	1·19	5·00
Burmah	14	1·08	4·25

4th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·779	—·059	SW	11	101	0·81
Diamond Island	·728	—·077	S	19	223	0·41
Akyab	·596	—·141	S	10	256	0·92
Chittagong	·522	—·174	E	6	84	1·51
Dacca	·512	—·132	NE	9	117	2·14
Jessore	·495	—·146	ENE	7	140	0·87
Calcutta	·475	—·132	ENE	5	80	1·08
Saugor Island	·440	—·168	NNE	6	45	0·30
Cuttack	·489	—·133	Calm	P	P	0·29

The small depression occupied the north-west angle of the Bay on the morning of the 4th. The centre had advanced very slightly during the past 24 hours, and was still to the south-east of Saugor Island, and near the Sandheads. Strong winds had now advanced into Eastern Bengal. The character of the winds was unchanged in the northern and western quadrants. They were remarkably feeble at the two stations nearest to the centre, *viz.*, Saugor Island and Cuttack. The character of the rainfall was slightly changed. It was diminishing in amount in Burmah, and increasing in Eastern Bengal.

The rainfall in the northern and western quadrants was small, as is shown by the following averages :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest fall in 24 hours preceding 6 P.M.
Orissa	14	0·64	1·25
South-West Bengal	48	0·47	2·27
North Bengal	25	0·03	0·25
East Bengal	24	1·84	6·45
Burmah	14	0·82	2·31

5th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·754	—·051	S	15	176	0·26
Akyab	·629	—·108	S	5	128	1·37
Chittagong	·594	—·102	E	8	113	4·26
Dacca	·548	—·096	ESE	12	156	3·08
Jessore	·441	—·200	E	8	160	0·74
Calcutta	·403	—·204	N	5	80	0·27
Saugor Island	·437	—·171	WNW	8	60	1·31
False Point	·482	—·155	WSW	14	136	1·08

The observations of the 5th and 6th are difficult to reconcile. The depression at the head of the Bay on the 4th passed into South-West Bengal on the morning of the 5th, and the centre at 10 A.M. was to the east of Calcutta. This whirl (judging from the 4 P.M. observations) apparently travelled northwards and filled up during the day. Heavy rain fell over the whole of Eastern Bengal. The following gives average rainfall data of the previous 24 hours :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest fall in 24 hours preceding 6 P.M.
South-West Bengal	48	1·18	4·80
North Bengal	25	0·15	2·19
East Bengal	24	2·89	9·57

Amounts exceeding 5 inches were registered for the previous 24 hours in the following cases :—

	Inches.		Inches.
Noakholly	9·57	Patuakholly	5·48
Madaripur	6·98	Bhola	5·44
Burrisal	6·20	Commilla	5·23
Munshiganj	5·56	Faridpur	5·20

6th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Cuttack	29·488	—·134	W	1	23	0·49
False Point	·485	—·147	WSW	10	95	3·02
Saugor Island	·518	—·089	ESE	11	79	0·49
Calcutta	·540	—·067	SE	9	141	1·15
Burdwan	·559	—·049	ESE	12	235	0·07
Hazaribagh	·561	—·012	E	17	189	0·51
Sambalpur	·462	—·119	N	5	172	*Nil.*

The preceding observations show that the winds had shifted at Saugor Island and the neighbouring stations in such a manner as to indicate the existence of a second depression and cyclonic circulation in the north-west angle of the Bay. This was, so far as can be judged from the 4 P.M. observations of the previous day, not the direct continuation of the vortex which had passed on the 5th into South and Central Bengal, but a second depression which formed in the rear of the preceding, and was due to the same general disturbance accompanying the advance of strong southerly humid winds over the north of the Bay. Winds were considerably below their normal strength at the nearest stations, Saugor Island, False Point, and Cuttack. Strong winds, on the other hand, prevailed, not only along the east coast of the Bay, but also in Central and North Bengal, and Behar. The centre was probably midway between False Point and Saugor Island at 10 A.M. Rain continued in South and East Bengal, but fell in smaller amounts than during the previous 24 hours. It was, on the other hand, discharged in larger quantities in Orissa, which received an average of nearly one and a half inches during the day. The following gives the average rainfall data :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Bengal	South-West Bengal	48	1·13	4·04
	East Bengal	24	1·40	4·55
	North Bengal	25	0·12	0·92
Orissa	Cuttack District	5	1·43	3·10
	Pooree District	3	1·86	4·38
	Balasore District	6	0·95	3·02

7th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Calcutta	29·686	+·079	WNW	8	182	1·48
Hazaribagh	·606	+·033	SE	18	200	0·34
Patna	·647	+·068	E	11	275	*Nil.*
Sutna	·585	+·024	E	17	175	*Nil.*
Jubbulpore	·523	—·090	NNE	5	90	*Nil.*
Seoni	·522	—·093	NW	9	161	0·21
Raipur	·557	—·046	W	19	244	3·22
Sambalpur	·534	—·047	SE	3	103	0·20

The depression had travelled rapidly westwards during the previous 24 hours, and occupied the north-eastern districts of the Central Provinces at 10 A.M. The centre was probably north of Raipur in latitude 21° 30′ North and longitude 82° East at 10 A.M. The Bombay monsoon current was blowing across the peninsula in moderate force, and gave fresh supplies of vapour to the whirl. The rainfall of the preceding 24 hours was not large in amount in the Central Provinces. The Chhattisgarh division, through which it was passing, received moderate rain. Orissa obtained an average of nearly an inch and a half during the day. The following table indicates the distribution of the rainfall of the previous 24 hours:—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Orissa	Cuttack District	5	1·32	3·60
	Pooree District	3	1·71	2·29
	Balasore District	6	1·21	2·52
Central Provinces	Nagpur	24	0·92	3·00
	Jubbulpore	22	0·09	0·65
	Nerbudda	22	0·83	3·10
	Chhattisgarh	15	1·10	3·22

8th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall at in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Raipur	29·573	—·030	S	21	269	0·32
Jubbulpore	·520	—·093	ENE	8	140	0·07
Hoshangabad	·550	—·102	W	8	167	4·02
Amraoti	·591	—·070	WNW	11	157	2·12
Akola	·609	—·057	WNW	11	125	1·13
Nagpur	·531	—·107	NW	11	157	3·17
Seoni	·502	—·113	NE	8	143	3·45
Pachmarhi	?	?	NW	?	?	0·31

The disturbance had advanced slowly to the westward during the previous 24 hours, and now covered the Nerbudda and Nagpur divisions of the Central Provinces. The depression was small in amount, not exceeding one-eighth of an inch at the centre, which was now a little to the south of Seoni in latitude 21° 30′ North and longitude 79° 30′ East. The continuance of the depression was evidently due to the increased supplies of vapour from the west coast, which gave heavy rainfall to the Nerbudda and Nagpur divisions during the day. The effect of the depression, in increasing the air circulation in the more elevated districts of the Central Provinces, is very clearly shown by the wind and anemometric observations. The following table gives the average rainfall in Orissa and the Central Provinces for the preceding 24 hours :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Orissa	Cuttack District	5	0·61	2·35
	Pooree District	3	1·02	2·60
	Balasore District	6	0·59	2·20
Central Provinces	Nagpur	24	2·32	5·00
	Jubbulpore	22	0·29	3·45
	Nerbudda	22	2·08	4·98
	Chhattisgarh	15	0·32	1·90

9th June.

Station.	Barometer reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nagpur	29·608	—·030	SW	12	171	2·17
Seoni	·563	—·052	SE	8	142	1·93
Jubbulpore	·547	—·066	S	6	150	1·19
Hoshangabad	·528	—·124	WNW	6	125	6·38
Khandwa	·568	—·096	W	18	185	0·23
Amraoti	·636	—·025	WNW	17	242	2·90

The depression had moved to the north-westward during the preceding 24 hours. The cyclonic circulation at 10 A.M. was much less regular than it had hitherto been The centre was apparently a few miles to the north-east of Hoshangabad. The depression was filling up. Very heavy rain had fallen in the Nerbudda division of the Central Provinces during the previous 24 hours. Strong westerly winds had fed it with vapour

from the west coasts, but they were now diminishing in intensity. The following table gives average rainfall results of the preceding 24 hours :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during 24 hours preceding 6 P.M.
Orissa		14	0·27	1·00
Central Provinces	Nagpur	24	0·73	2·72
	Jubbulpore	22	0·11	0·60
	Nerbudda	22	2·31	6·15
	Chhattisgarh	15	0·05	0·70

The depression filled up during the day, and on the morning of the 10th, normal westerly winds prevailed over the whole of the Central Provinces and Central India, and gave occasional rain showers, but the amounts were nowhere large. The storm thus terminated on the evening of the 9th.

(*No. XXXIX.*)—*Storm of June 13th to the 19th.*—This storm was generated near the head of the Bay, and apparently in front of a strong advance of monsoon winds which followed the preceding burst. It advanced slowly across the Orissa coast in a general northerly direction through Chutia Nagpur into Behar. The strength of the inflow of moist winds which accompanied it was shown by the occurrence of very heavy rainfall over the whole of Bengal and Behar, and more especially in East and North Bengal.

13th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·856	+·018	SW	11	101	0·98
Diamond Island	·793	—·011	SSW	7	81	1·40
Akyab	·693	—·043	SSE	5	128	1·06
Chittagong	·686	—·007	SE	5	71	0·03
Saugor Island	·599	—·008	SSE	8	58	*Nil.*
False Point	·596	—·036	WSW	5	48	*Nil.*

The observations prove that the strong southerly winds, which had prevailed at the head of the Bay during, and immediately after, the preceding storm, decreased rapidly in strength, and were considerably below their normal force on the 13th. The distribution of pressure over the Bay was almost identical with the normal. The rainfall had also diminished considerably in amount, and was confined to local showers, which occurred

chiefly near the hills of North and East Bengal. The distribution of the rainfall of the 13th is indicated by the following data :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Orissa	14	0·40	2·26
South-West Bengal	48	0·13	3·86
North Bengal	25	0·45	6·00
East Bengal	24	0·25	1·29
North Behar	18	0·09	1·34
South Behar	23	0·03	0·25

14th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·833	+·029	SSW	7	81	2·81
Akyab	·748	+·012	SSW	6	154	1·27
Chittagong	·654	—·039	SE	6	86	0·52
Dacca	·596	—·047	ESE	8	107	0·44
Jessore	·567	—·074	ESE	3	60	0·10
Berhampore	·571	—·047	E	8	145	*Nil.*
Calcutta	·533	—·074	ENE	4	62	0·28
Saugor Island	·538	—·069	NNW	7	50	0·44
False Point	·568	—·064	W	11	105	*Nil.*

The winds at the head of the Bay show that a cyclonic circulation of feeble intensity had been established during the previous 24 hours. Winds were irregular in strength in Bengal, but were generally much below their normal force. Moderately heavy rain was falling on the Burmah and Aracan coasts, and was advancing northwards. Strong winds, as indicated by the Akyab observations, prevailed in the eastern quadrant.

The following table gives the average rainfall of the previous 24 hours in Bengal :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Orissa	14	0·39	2·06
South-West Bengal	48	0·45	2·41
North Bengal	25	0·27	3·40
East Bengal	24	0·65	9·98
North Behar	18	0·12	1·20
South Behar	23	0·19	1·44

15th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
False Point	29·509	—·123	WSW	12	114	0·02
Saugor Island	·488	—·119	SW	16	115	0·53
Jessore	·491	—·150	S	2	40	0·99
Calcutta	·469	—·138	S	5	78	1·44
Dacca	·523	—·120	S	10	133	0·37
Burdwan	·450	·158	S	3	59	0·12
Berhampore	·461	—·157	SE	6	109	0·38
Purneah	·489	—·123	E	4	103	*Nil.*
Patna	·489	—·090	ENE	6	150	*Nil.*
Hazaribagh	·534	—·039	NE	5	56	0·14

The small disturbance had crossed the coast near the mouth of the Hooghly, and travelled northwards during the previous 24 hours. The centre, at 10 A.M., was 20 or 30 miles to the west of Burdwan. Winds had increased in force in South Bengal, but they were still moderate in force and irregular in character. The disturbance was evidently at this time a small and feeble one. The depression at the centre was less than two-tenths of an inch.

The rainfall was larger in amount in Bengal than during the previous 24 hours, but was, like the disturbance, diffused.

The following table gives its distribution :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Orissa	14	0·13	0·75
South-West Bengal	48	0·55	4·25
North Bengal	25	0·32	1·36
East Bengal	24	0·69	3·42
North Behar	18	0·06	0·60
South Behar	23	0·45	2·50

16th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Dacca	29·547	—·096	S	9	120	0·03
Saugor Island	·512	—·095	SSW	19	137	*Nil.*
Calcutta	·498	—·109	SSW	4	62	0·03
Jessore	·516	—·125	SSE	4	80	*Nil.*
Burdwan	·498	—·110	S	4	78	0·68
Berhampore	·500	—·118	Calm	4	73	0·70
Purneah	·495	—·117	E	4	103	0·42
Durbhanga	·567	—·031	NE	4	75	3·41
Patna	·529	—·050	NW	4	100	0·22
Hazaribagh	·513	—·060	NNW	11	122	2·15
Sambalpur	·569	—·012	NW	3	103	0·09
Cuttack	·550	—·072	WNW	2	45	0·02
False Point	·535	—·097	WSW	13	124	0·40

The observations show that the disturbance now covered the whole of Bengal and Orissa, and the greater part of Behar. The depression was almost the same in amount over the whole area represented by the stations of Calcutta, Burdwan, Purneah, Berhampore, and Jessore, and there was apparently no definite centre of barometric depression. The centre of the cyclonic circulation seems to have been at this time in the neighbourhood of Berhampore and Burdwan. Winds were below their normal strength over the greater part of the area of minimum depression, and the cyclonic circulation was very feeble. Rain was falling in larger amounts than before, and was, like the disturbance, widely diffused. East Bengal and Behar received the largest quantities. The following table gives its distribution :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of preceding 24 hours.
Orissa	14	0·14	1·30
South-West Bengal	48	0·47	2·75
North Bengal	25	0·69	2·48
East Bengal	24	1·00	4·20
North Behar	18	0·99	4·65
South Behar	23	1·53	6·24

17th June.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Calcutta	29·534	—·073	WSW	6	94	0·06
Burdwan	·521	—·087	W	6	118	*Nil.*
Berhampore	·491	—·127	WSW	8	145	0·12
Jessore	·543	—·098	WSW	1	20	0·35
Dacca	·543	—·100	S	9	120	0·03
Dhubri	·569	—·082	ESE	7	152	0·98
Purneah	·517	—·095	E	9	230	0·70
Durbhanga	·545	—·053	NW	1	20	3·41
Patna	·556	—·023	SE	2	50	3·79
Gya	·577	—·009	N	1	31	1·30
Hazaribagh	·581	+·008	NW	13	144	1·04

The disturbance had advanced a little distance northwards, and was somewhat more clearly defined than on the 16th. The depression was now greatest at Berhampore, and the centre was nearly midway between Berhampore and Purneah at 10 A.M. In other respects its character was unchanged. It was a widely diffused disturbance, giving general and heavy rain over the whole of North and East Bengal, and Behar. The winds were generally feeble, more especially in the western quadrant. They were, however, increasing rather rapidly in force at Purneah and Dhubri, indicating a considerable indraught from the Bay of Bengal to the northern districts of Bengal. The average rainfall of the previous 24 hours is given below:—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·02	0·20
South-West Bengal	48	0·43	2·17
North Bengal	25	1·30	6·96
East Bengal	24	1·33	6·93
North Behar	18	1·25	5·35
South Behar	23	1·72	5·41

18th June.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall of 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Hazaribagh	29·587	+·014	W	6	67	*Nil.*
Burdwan	·608	0	WSW	6	118	0·06
Calcutta	·597	—·010	SW	7	109	1·13
Berhampore	·596	—·022	WSW	8	145	*Nil.*
Jessore	·608	—·033	Calm	1	20	0·01
Dacca	·585	—·058	SW	8	107	0·85
Dhubri	·566	—·085	ENE	7	152	0·76
Purneah	·550	—·062	NW	20	513	11·15

The vortex had continued to advance northwards during the previous 24 hours, and was to the north-east of Purneah at 10 A.M. The barometric depression was considerably smaller in amount, and the disturbance was evidently filling up. It had become more limited in extent, and excessive rain had fallen in the Purneah district. Purneah received 11·15 inches during the previous 24 hours. The indraught to the area of heaviest rainfall was hence much greater, and unusually strong winds prevailed at Purneah during the day.

The following gives the distribution of the rainfall of the previous 24 hours :—

	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during previous 24 hours.
Orissa	14	...	0·05
South-West Bengal	48	0·27	1·43
North Bengal	25	0·74	4·05
East Bengal	24	1·54	4·07
North Behar	18	1·34	11·15
South Behar	23	0·13	1·09

The observations of the 19th show no trace of the cyclonic circulation. The depression hence filled up on the evening of the 18th.

(*No. XL.*)—*Storm of July 2nd to the 4th.*—This storm formed under similar circumstances to the preceding near the head of the Bay. It crossed the Balasore coast, and passed over the Orissa hills into the Central Provinces, where it disappeared after a brief existence.

1st July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·786	—·064	SW	18	147	1·55
Diamond Island	·737	—·072	WSW	5	55	0·09
Akyab	·680	—·049	S	2	55	3·51
Chittagong	·643	—·043	SSW	6	83	0·04
Saugor Island	·557	—·039	SW	15	113	*Nil.*
False Point	·568	—·058	W	10	103	0·05
Vizagapatam	·623	—·043	W	4	93	0·30

The observations of the 1st indicate that strong south-west monsoon winds were blowing at Port Blair, and that winds were light on the Aracan and East Bengal coast. An advance of strong south-west monsoon winds was hence in progress up the east of

the Bay. Normal winds prevailed in Bengal and Orissa. The rainfall was moderate in amount, as is shown by the averages for the previous 24 hours given in the following table :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Bengal	South-West Bengal	47	0·34	2·22
	North Bengal	25	0·83	3·39
	East Bengal	24	0·34	2·50
Orissa		14	0·34	2·00
Behar		41	0·04	0·90
Central Provinces	Nagpur	22	0·58	3·28
	Jubbulpore	18	0·18	1·41
	Nerbudda	22	0·33	2·70
	Chhattisgarh	14	0·13	0·97

2nd July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall, 10 A.M. previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·774	—·076	SW	6	49	1·90
Diamond Island	·727	—·082	SSW	8	88	0·51
Akyab	·640	—·089	SSW	3	83	2·53
Chittagong	·612	—·074	E	4	56	0·23
Saugor Island	·512	—·084	ENE	7	53	0·97
False Point	·518	—·108	WNW	8	82	0·25
Vizagapatam	·563	—·103	W	2	46	0·80

The observations of the 2nd prove that a small depression was formed in the north-west angle of the Bay, over which the air was moving cyclonically. The depression was evidently small, and the winds at all the neighbouring land stations very feeble. The centre was to the south of Saugor Island, and probably not far from the Sandheads. The rainfall over Bengal had been very considerably diminished by the indraught to the depression, as is shown by the following table :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Bengal	South-West Bengal	47	0·26	3.39
	North Bengal	25	0·04	0·73
	East Bengal	24	0·09	1·51
Orissa		14	0·68	1.55
Behar		41	0·22	2·43

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Central Provinces	Nagpur	22	1·24	3·45
	Jubbulpore	18	0·07	0·40
	Nerbudda	22	0·35	2·19
	Chhattisgarh	14	0·50	2·02

3rd July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Saugor Island	29·554	—·042	SSE	9	68	1·86
Sambalpur	·507	—·109	E	1	·33	0·22
Raipur	·532	—·097	E	8	70	0·68
Nagpur	·571	—·082	NW	5	70	1·04
Sironcha	·621	—·141	NW	4	90	1·88
Vizagapatam	·557	—·109	W	1	23	0·50

The depression had advanced rapidly to the westward during the previous 24 hours, and the centre was at 10 A.M. in the southern districts of the Central Provinces to the south-west of Sambalpur. The air circulation was very feeble, and considerably below the ordinary atmospheric motion of the month. It was, however, a clearly-defined depression and cyclonic circulation, and gave moderately heavy rain to the Chhattisgarh division of the Central Provinces, through which it was passing. The following table gives the average rainfall in Bengal and the Central Provinces during the previous 24 hours :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·42	2·33
	North Bengal	25	0·21	1·94
	East Bengal	24	0·24	0·78
Orissa		14	0·67	1·75
Central Provinces	Nagpur	18	0·88	2·90
	Jubbulpore	22	0·44	2·20
	Nerbudda	22	0·69	2·27
	Chhattisgarh	12	1·04	2·52

4th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Raipur	29·562	—·053	SW	6	53	0·22
Jubbulpore	·581	—·042	S	3	58	1·05
Seoni	·544	—·084	SE	4	67	0·21
Nagpur	·559	—·094	W	4	56	0·56
Hoshangabad	·558	—·093	W	2	43	3·56
Khandwa	·657	+·002	NW	8	92	*Nil.*
Akola	·623	—·054	NNW	8	96	0·54
Amraoti	·607	—·067	ENE	6	84	0·73

The depression was now in the Nagpur Division of the Central Provinces, the centre being midway between Nagpur and Seoni. The barometer at the centre was barely a tenth of an inch below the normal. The winds were below their average strength over the whole of the Central Provinces, so that no indraught on the large scale from the Bombay coast had been initiated by the disturbance. The rainfall was hence comparatively small in amount. Its character and distribution are shown by the following table:—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Central Provinces	Nagpur	20	0·86	2·10
	Jubbulpore	22	0·77	3·90
	Nerbudda	22	0·93	5·20
	Chhattisgarh	12	0·36	1·42

The observations of the 5th prove that there was no longer any trace of cyclonic circulation in the Central Provinces. The disturbance hence filled up on the afternoon of the 4th.

(*No. XLI.*)—*Storm of July 12th to the 18th.*—This storm commenced to form at the head of the Bay on the 12th. It developed very slowly on the 13th, 14th, and 15th, during which period it altered its position very slightly, so far as can be inferred from the land observations. The disturbance was slightly more concentrated than is usual for a storm of the rains on the evening of the 15th. It crossed the coast early on the morning of the 16th, passed slowly northwards for some hours, and then

advanced rapidly to the westwards through Chutia Nagpur and Baghelkhand into Central India, where it filled up on the evening of the 18th.

12th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·827	—·023	SW	19	156	0·51
Diamond Island	·759	—·050	SW	10	110	3·71
Akyab	·645	—·084	SE	2	56	1·07
Chittagong	·633	—·053	SE	4	56	*Nil.*
Dacca	·625	—·010	SE	7	93	0·01
Jessore	·593	—·040	NNE	2	43	0·07
Calcutta	·566	—·034	WNW	3	59	0·25
Saugor Island	·581	—·015	WNW	15	113	*Nil.*
Cuttack	·593	—·028	Calm	1	30	0·03

The preceding observations indicate that the usual conditions were present at the commencement of a small storm at the head of the Bay. Steady south-west monsoon winds were blowing at the Andamans and on the Burmah coast, and were advancing northwards; winds were light in Bengal, and the rainfall was very limited in amount and partial in character. A break in the rains obtained in Bengal and Behar. The conditions on the Bombay coast were peculiar. A land-formed depression was giving excessive rain at this time to a small area, extending over the greater part of Guzerat and Cutch. It is described by Mr. Blanford in the Meteorological Memoirs, Vol. II, pages 79-101. Hence neither the Bombay nor the Bengal branch of the monsoon current reached the interior, and an almost complete break in the rains was established over Central and Northern India. The wind observations at the stations on the north coast of the Bay were such as accompany vorticose motion of the air at the head of the Bay, which had either been initiated or had extended to the Bengal coast during the previous 24 hours.

The following table gives the distribution of rainfall in Bengal on the 12th July:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during previous 24 hours.
Orissa	14	0·11	0·84
South-West Bengal	47	0·11	0·72
East Bengal	24	0·06	0·42
North Bengal	25	0·01	0·15
North Behar	18	0	0·03
South Behar	23	0·19	1·10

13th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·774	—·035	SW	11	121	0·84
Akyab	·624	—·105	S	4	111	0·82
Chittagong	·592	—·094	ENE	4	56	0·02
Jessore	·566	—·067	SE	3	65	0·65
Calcutta	·558	—·042	E	3	59	0·30
Saugor Island	·545	—·051	NNW	9	68	0·32
False Point	·590	—·036	Calm	?	?	0·64

The depression had intensified very slightly during the previous 24 hours, and was to the south-east of Saugor Island. The general conditions were unchanged. Winds were very light in the south of Bengal. The rainfall was slightly larger in amount in the coast area of Bengal and Orissa. Little or no rain was falling in the interior. The break in the rains was even more complete than on the 12th.

The following table gives the distribution of rainfall during the previous 24 hours in Bengal:—

Division	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·23	0·80
South-West Bengal	47	0·48	6·15
East Bengal	24	0·09	0·67
North Bengal	25	0·03	0·70
North Behar	18	0·06	0·38
South Behar	23	0·16	1·00

14th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in last 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Akyab	29·622	—·107	SSW	6	167	1·69
Chittagong	·558	—·128	E	5	69	0·04
Dacca	·544	—·091	ESE	4	53	0·05
Jessore	·528	—·105	NNE	4	87	0·02
Berhampore	·555	—·065	Calm	5	100	0·20
Burdwan	·538	—·063	NE	3	67	1·15
Calcutta	·520	—·080	N	6	118	0·26
Saugor Island	·524	—·072	NNW	10	75	3·13
False Point	·574	—·052	W	9	93	0·43

The depression apparently occupied almost the same position as on the 13th. The cyclonic circulation was more fully developed, but the barometric depression was almost unaltered in amount. The winds were, however, increasing in force, and commencing to pour moderate supplies of aqueous vapour into the Province of Bengal, and rain was consequently falling in largish amounts, especially on the Bengal and Orissa seaboard.

The following table gives its distribution for the 14th :—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the previous 24 hours.
Orissa	14	0·85	2·90
South-West Bengal	47	0·84	8·00
East Bengal	24	0·26	1·92
North Bengal	25	0·32	1·50
North Behar	18	0·32	1·66
South Behar	23	0·65	4·66

15th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Akyab	29·576	—·153	W	7	194	2·95
Chittagong	·490	—·196	SE	7	97	*Nil.*
Dacca	·447	—·188	E	7	93	0·24
Jessore	·413	—·220	ENE	11	239	0·12
Berhampore	·471	—·149	ENE	8	160	*Nil.*
Burdwan	·437	—·164	NE	6	133	0·63
Calcutta	·392	—·208	ENE	10	196	1·25
Saugor Island	·355	—·241	NNE	15	113	2·55
False Point	·490	—·136	WSW	20	206	3·77
Cuttack	·537	—·084	WSW	4	118	4·55

The depression occupied almost the same position as on the 13th and 14th. The centre had apparently drifted slightly to the westward or north-westward. The barometer had fallen rapidly during the previous 24 hours, and the depression had intensified very considerably during this interval. The barometric depression at Saugor Island, the station nearest to the centre, was a quarter of an inch. The winds had strengthened very considerably over the whole of South Bengal and Orissa, and the cyclonic circulation was more vigorous, regular, and strongly marked than hitherto. Unusually

general and heavy rain had fallen during the previous 24 hours in Orissa, and moderate rain in Bengal. The following gives average data for the 24 hours preceding 6 P.M. :—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Orissa	14	3·42	6·50
South-West Bengal	47	0·68	2·97
East Bengal	24	0·29	1·27
North Bengal	25	0·15	1·30
North Behar	18	0·91	3·00
South Behar	23	0·89	5·52

16th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours preceding 10 A.M.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Cuttack	29·417	—·204	W	8	235	3·19
False Point	·316	—·310	WSW	26	268	3·17
Saugor Island	·283	—·313	SW	17	128	0·81
Calcutta	·287	—·313	ESE	15	294	0·24
Jessore	·397	—·236	E	12	261	0·20
Burdwan	·351	—·250	ENE	10	222	0·10
Berhampore	·400	—·220	E	24	480	...
Hazaribagh	·433	—·150	NE	12	140	0·82

The centre crossed the coast near the mouth of the Hooghly early on the morning of the 16th, and was at 10 A.M. nearly midway between Saugor Island and Calcutta, at each of which stations the depression slightly exceeded three-tenths of an inch. Unusually strong winds prevailed in Bengal during the day, and brought up much vapour and cloud, and gave moderate to heavy rain over the whole Province, but more especially in Orissa. The following gives average amounts for the previous 24 hours :—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall during the preceding 24 hours.
Orissa	14	2·25	4·70
South-West Bengal	47	0·28	2·19
East Bengal	24	0·26	1·18
North Bengal	25	0·36	1·50
North Behar	18	0·08	0·53
South Behar	23	0·51	2·40

17th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Hoshangabad	29·525	—·126	WNW	8	170	1·74
Seoni	·452	—·176	SW	15	259	2·22
Jubbulpore	·370	—·253	E	10	192	2·50
Sutna	·480	—·094	NE	10	106	*Nil.*
Allahabad	·441	—·121	ENE	4	108	0·01
Nowgong	·427	—·152	ENE	7	152	*Nil.*

The preceding observations show that the depression had been transferred rapidly westwards, and was at 10 A.M. in the Central Provinces. The air motion was somewhat irregular. The centre of cyclonic circulation and of greatest depression was between Jubbulpore and Seoni, and only a few miles south of Jubbulpore. Winds were considerably above their average strength in the immediate neighbourhood of the centre. Heavy rain fell over the whole of the western and central districts of the Central Provinces, as is shown by the following table:—

Division.		Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Central Provinces	Nagpur	20	2·07	7·90
	Jubbulpore	22	1·07	4·71
	Nerbudda	22	2·35	5·58
	Chhattisgarh	14	1·16	3·00

18th July.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Khandwa	29·673	+·018	SW	11	126	0·62
Saugor	·640	+·037	SW	3	65	0·82
Jubbulpore	·594	—·029	W	4	77	2·62
Jhansi	·513	—·048	NE	5	125	*Nil*
Agra	·536	—·024	E	11	220	*Nil.*
Ajmere	·531	—·049	NE	4	58	*Nil.*
Neemuch	·507	—·118	NE	17	143	0·95
Indore	·578	—·088	W	11	162	3·58
Hoshangabad	·590	—·061	WSW	11	234	5·05

The disturbance had advanced slowly westwards during the previous 24 hours. The barometric depression was considerably smaller than on the 17th. The centre was between Indore, Hoshangabad, Jhansi, and Neemuch, in Central India. The air motion was much more irregular than on the 17th, and the rainfall much smaller in amount, thus indicating that it was now in process of disintegration. It completely disappeared before the morning of the 19th July. The following gives average rainfall data of the Central Provinces for the previous 24 hours:—

Division.		Number of stations.	Average rainfall of 24 hours preceding 8 P.M.	Heaviest rainfall of 24 hours preceding 8 P.M.
Central Provinces	Nagpur	20	0·77	2·30
	Jubbulpore	22	0·44	1·95
	Nerbudda	22	0·67	2·55
	Chhattisgarh	14	0·34	2·25

The following were the more remarkable features of the storm:—

1st.—It developed with unusual slowness at the head of the Bay. It commenced to form on the 12th, and advanced very slowly until the afternoon of the 15th, when it passed across the Bengal coast.

2nd.—Its rapid transfer on the afternoon of the 16th, and morning of the 17th to the Central Provinces, which accompanied a short but very heavy burst of rain over the whole of that area.

(*No. XLII.*)—*Storm of August 1st to the 4th.*—This was a small storm which formed at the head of the Bay under similar circumstances to the preceding. Although a very feeble storm, as judged by the force of the winds, or the amount of the central depression, it advanced across the Orissa hills, and marched rapidly across the continent to the shores of the Arabian Sea in Guzerat or Cutch. It was, as will be seen, only remarkable for the rapidity with which it moved across the continent.

1st August.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·768	—·095	SW	21	206	0·85
Diamond Island	·680	—·158	WSW	10	135	2·81
Akyab	·575	—·194	SSE	4	129	0·34
Chittagong	·550	—·189	SE	5	83	0·01
Jessore	·513	—·174	WSW	12	293	0·10
Calcutta	·461	—·203	E	5	94	0·77
Saugor Island	·464	—·195	NW	12	105	0·80
False Point	·481	—·202	W	?	?	*Nil.*

The observations show that a considerable depression had formed over the north-west angle of the Bay, and the adjacent coast districts. The centre was probably not far from the coast of the Sunderbunds, and some distance to the south-east of Saugor Island. Strong humid winds of indraught were blowing over the east and north-east of the Bay. Winds were irregular in force in Bengal, and were below their normal strength at many stations. Rainfall, as usual during the formation of the smaller cyclonic storms of the Bay, was small in amount in Bengal. The following table gives its distribution :—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
South-West Bengal	47	0·45	2·92
North Bengal	25	0·09	0·72
East Bengal	24	0·20	0·88

2nd August.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·733	—·105	SSW	11	149	0·79
Akyab	·659	—·110	SSE	5	161	0·31
Chittagong	·636	—·103	SE	4	67	*Nil.*
Saugor Island	·468	—·191	E	9	79	1·34
False Point	·398	—·285	N	1	?	0·48
Cuttack	·429	—·249	NNE	1	37	0·91
Vizagapatam	·540	—·174	W	4	125	0·20

The disturbance had intensified slightly during the preceding 24 hours, and moved westwards. The centre was not far from the Orissa coast, and was advancing westwards to the coast between Chandbally and False Point. The northerly winds in the western quadrant were extremely feeble, and were only one-third of their normal strength at Cuttack. The rainfall was slightly larger in amount in Bengal. Moderate rain was also being received in the Central Provinces, thus indicating that the Bombay current

was blowing under normal conditions. The following table gives the distribution of rainfall for the 2nd of August :—

Province.	Division.	Number of Stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·28	1·50
	North Bengal	25	0·16	1·40
	East Bengal	24	0·32	1·16
Orissa		14	0·83	3·58
Central Provinces	Nagpur	24	0·51	4·50
	Jubbulpore	22	0·70	3·28
	Nerbudda	22	0·32	1·67
	Chhattisgarh	16	0·69	2·65

3rd August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Vizagapatam	29·606	—·108	WSW	4	125	*Nil.*
False Point	·578	—·105	SSW	?	?	0·64
Saugor Island	·611	—·048	SSE	17	149	0·34
Nagpur	·502	—·205	NW	6	109	5·93
Raipur	·590	—·084	SW	11	169	2·83
Jubbulpore	·483	—·207	E	3	62	1·08
Saugor	·537	—·152	NE	5	132	*Nil.*
Hoshangabad	·486	—·241	NE	2	56	1·67
Khandwa	·566	—·148	W	9	117	0·71
Seoni	·491	—·197	NE	6	133	0·84

The depression had been transferred rapidly westwards during the previous 24 hours, and was, at 10 A.M. of the 3rd, in the northern and central districts of the Central Provinces. The centre was between Nagpur and Seoni in latitude 21° 45′ North and longitude 79° 45′ East. Strong southerly winds were now blowing across the Orissa and Bengal coasts. Winds were slightly above their normal strength in the Central Provinces. Moderate rain had fallen in the Chhattisgarh Division during the passage of the cyclonic

storm. The amount of rain accompanying its motion increased considerably as it passed through the Nagpur and Nerbudda Divisions.

The rainfall in the Central Provinces at this time is given below—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Central Provinces	Nagpur	24	1·78	6·55
	Jubbulpore	22	0·29	1·45
	Nerbudda	22	1·06	3·69
	Chhattisgarh	16	0·60	2·83

The rainfall was, as is usual in the case of storms passing through the Central Provinces, heaviest to the south and south-west of the path of the storm centre or vortex, and was small in amount in the northern half of the area of depression.

4th August.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Bombay	29·668	—·137	WSW	25	157	8·56
Khandwa	·597	—·119	SW	5	66	1·07
Nagpur	·647	—·060	SW	8	145	0·76
Deesa	·491	—·215	ESE	8	67	0·13
Ajmere	·538	—·126	NE	6	122	0·40
Bhuj	·496	—·187	NW	9	60	1·29
Rajkot	·545	—·179	W	13	103	1·16
Surat	·584	—·171	W	23	168	0·80
Kurrachee	·565	—·097	N	10	58	0·36

The depression had advanced rapidly to the westwards during the previous 24 hours. The centre was now between the three stations of Rajkot, Deesa, and Bhuj, in about latitude 24° North and longitude 71° 30′ East. The depression at the centre did not exceed a quarter of an inch. The winds were stronger than the normal in the southern quadrant, but the air circulation over the area of depression was, as it had been previously, comparatively feeble. The rainfall was much less concentrated than on the 2nd and 3rd. The westerly winds on the Bombay coast, which had been strengthened by the indraught to the vortex, were discharging their vapour chiefly on the coast area and hills

near Bombay. The following were the largest amounts recorded in the Bombay Presidency for the 24 hours preceding 6 A.M. :—

Station.	Inches.	Station.	Inches.
Mahabaleshwur	9·12	Satara	1·94
Tanna	6·20	Hyderabad	1·51
Matheran	4·07	Rajkot	1·34
Lanauli	3·65	Bhuj	1·29
Igatpuri	3·65	Kurrachee	1·08
Byculla	3·37		

The following table gives the rainfall in the Central Provinces during the previous 24 hours, and shows that it was small in amount compared to the rainfall of the preceding day :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Central Provinces	Nagpur	24	0·44	2·60
	Jubbulpore	22	0·13	0·99
	Nerbudda	22	0·26	2·13
	Chhatisgarh	16	0·01	0·10

The observations of 4 P.M. of the 4th show that the cyclonic circulation was drifting rapidly westward, and filling up. It disappeared before the morning of the 5th, as the observations at 10 A.M. show no trace of its existence.

In common with many storms of the rains, it advanced across the head of the continent, and increased in intensity as it passed across the Central Provinces, where it drew moderately large supplies of vapour from the Bombay current. The rainfall was distinctly heaviest at some distance to the south and south-west of the path of the centre. The storm was a small one, and lacked concentration. Its most remarkable feature was the rapidity of its motion across the continent. This is illustrated by the following data :—

Date.	Position of Centre.		Distance travelled in previous 24 hours.	Rate of motion in miles per hour.
	Latitude.	Longitude.		
August 2nd, 10 A.M.	20° 30′ N	87° 30′ E	...	...
„ 3rd „	21° 45′ N	79° 45′ E	510	21
„ 4th „	24° 0′ N	71° 30′ E	550	23

(*No. XLIII.*)—*Storm of August 16th to the 19th.*—This was a very small storm, and of little importance. It formed in front of a moderate rush of monsoon winds up the east coast of the Bay, developed quickly to the south of Saugor Island into a storm of small

extent, but with a moderately large depression, and then passed rapidly to the west-north-west through Chutia Nagpur, when it commenced to fill up. It disappeared in less than 36 hours after it crossed the coast near Saugor Island.

16th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·724	—·114	SW	10	135	0·69
Akyab	·637	—·132	SE	4	129	*Nil.*
Chittagong	·728	—·011	E	4	67	0·03
Saugor Island	·581	—·078	SSE	6	53	*Nil.*
Calcutta	·586	—·078	ESE	4	75	*Nil.*
False Point	·624	—·061	W	11	121	0·08
Cuttack	·631	—·047	WNW	1	37	0·03
Vizagapatam	·686	—·028	W	3	94	*Nil.*

The observations show that the barometer was low at Diamond Island and Akyab, and that moderately strong monsoon winds were blowing. Winds were light in South Bengal and Orissa, and were commencing to shift round in the usual manner on the approach of a cyclonic disturbance to the head of the Bay. An almost complete break in the rains had obtained for two or three days previously in Bengal. The following table gives the average rainfall of the previous 24 hours—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·01	0·17
	North Bengal	25	0·02	0·42
	East Bengal	24	0·12	1·50

17th August.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·721	—·117	SW	10	135	1·99
Akyab	·609	—·160	SE	6	193	0·07
Chittagong	·611	—·128	NE	3	50	0·04
Saugor Island	·578	—·081	E	4	35	*Nil.*
Calcutta	·582	—·082	SE	3	57	*Nil.*
False Point	·586	—·097	WNW	7	77	*Nil.*
Cuttack	·595	—·083	Calm	?	?	*Nil.*
Vizagapatam	·623	—·091	WNW	4	125	*Nil.*

The observations indicate that cyclonic motion was now fully established over the head of the Bay. Strong southerly winds were blowing at Diamond Island and Akyab, whilst winds were even feebler in Bengal and Orissa than they were on the 16th. The rainfall in Bengal was very local and partial, and small in amount, as is shown by the following table:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
South-West Bengal	47	0·20	1·03
North Bengal	25	0·10	0·60
East Bengal	24	0·32	2·30
Orissa	14	0·07	0·44

18th August.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·761	—·077	SSW	10	135	0·06
Akyab	·695	—·074	SSW	6	193	1·65
Chittagong	·644	—·095	SE	4	67	0·69
Dacca	·588	—·106	SE	4	66	0·46
Jessore	·554	—·133	ESE	5	122	1·30
Burdwan	·542	—·126	ENE	4	105	0·06
Calcutta	·486	—·178	ENE	6	113	1·83
Saugor Island	·449	—·210	NNW	7	61	0·99
False Point	·541	—·142	WNW	7	77	3·64

The depression had intensified considerably during the previous 24 hours. The centre was to the south-east of Saugor Island, probably near the Sandheads, and the depression at the centre probably did not exceed a quarter of an inch. Winds were increasing in strength in Bengal. They, however, exhibited great irregularity, as is frequently the case in the minor cyclonic storms of the rains. Thus, the wind velocity at Saugor Island and False Point during the preceding 24 hours was very considerably below the normal of the month, and was practically the same as its average value for the previous 24 hours, whilst it had increased considerably at the more distant inland stations, as, for example, Calcutta, Burdwan, and Jessore, and was at these stations above the average.

Rainfall had increased considerably in amount in Bengal and Orissa, as is shown by the following table:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
South-West Bengal	47	0·68	2·10
North Bengal	25	0·71	3·66
East Bengal	24	0·78	2·82
Orissa	14	1·35	3·69

19th August.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction, 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
False Point	29·618	—·065	S	8	88	0·19
Saugor Island	·635	—·024	SSE	15	132	1·22
Calcutta	·643	—·021	SE	11	207	0·86
Burdwan	·637	—·031	ESE	8	210	1·11
Hazaribagh	·551	—·103	S	13	171	0·63
Gya	·568	—·092	SE	5	200	1·33
Allahabad	·561	—·076	E	4	129	0·67
Jubbulpore	·583	—·107	Calm	4	83	0·17
Raipur	·580	—·094	W	9	138	0·24
Sambalpur	·548	—·101	Calm	0·4	15	0·15

The depression had advanced rapidly to the west-north-west during the previous 24 hours through Orissa into the south-western districts of Chutia Nagpur. It was already much shallower, and less concentrated. The centre of the circulation appears to have been at 10 A.M. in latitude 23° 30′ North and longitude 83° 30′ East. Strong southerly winds had set in over Bengal, and were bringing up much vapour, which was being chiefly deposited in South-West Bengal, Behar, and Chutia Nagpur. The following table gives the distribution of the rainfall of the previous 24 hours:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
South-West Bengal	47	1·03	3·60
North Bengal	25	0·27	1·55
East Bengal	24	0·42	2·15
Orissa	14	0·85	5·25
North Behar	17	0·29	1·00
South Behar	23	0·54	1·55
Chutia Nagpur	10	1·25	3·50

The disturbance filled up during the afternoon and evening of the 19th.

(*No. XLIV.*)—*Storm of September 10th to the 14th.*—This was a small storm which formed in the usual manner in front of an advance of southerly humid winds along the east coast of the Bay. It advanced westwards, striking the Orissa coast near, and to the north of, False Point about 8 A.M. of the 12th. The vortex was in the neighbourhood of Hoshangabad at 10 A.M. of the 13th, about 560 miles to the west of its position at the same hour on the preceding day. This rapid transference may have been due to actual motion of an unbroken vortex, or to the formation of another vortex in front of it in the Central Provinces, produced by the actions set up when the former met the Orissa hills in its onward movement. The vortex moved more slowly during the next 24 hours through Central India, when it began to fill up. It gave heavy rain to Orissa and the Central Provinces, and moderate rain to Central India during its passage. The observations of the 11th first indicated its existence clearly.

11th September.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Diamond Island	29·811	—·047	SSW	11	162	2·78
Akyab	711	—·123	SSE	4	133	0·12
Chittagong	700	—·122	E	2	43	*Nil.*
Saugor Island	692	—·062	NE	3	32	*Nil.*
False Point	696	—·069	NNE	8	108	*Nil.*

The observations establish that there was a slight barometric depression near the head of the Bay (indicated most strongly by the Akyab and Chittagong barometric observations), and that the winds had shifted round to north-east at the head of the Bay in obedience to it. Moderately strong humid winds were blowing on the Burmah and Aracan coasts. Winds, as usual at the commencement of a cyclonic disturbance in the Bay, were exceedingly weak in South Bengal. Moderately heavy rain was falling in Burmah. An almost complete break of the rains prevailed in Bengal and Orissa. The following table gives average rainfall data :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Burmah	. . . . .	14	1·25	4·59
Bengal	East Bengal	24	0·03	0·43
	South-West Bengal	47	0·07	1·20
Orissa	. . . . .	14	0·20	1·40

12th September.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Raipur	29·685	—·062	NW	4	74	*Nil.*
Vizagapatam	·694	—·070'	WNW	3	125	0·30
False Point	·632	—·133	SSW	9	122	3·28
Cuttack	·617	—·147	NNW	1	45	6·29
Saugor Island	·647	—·107	SSE	8	85	0·67
Calcutta	·666	—·093	SE	10	213	0·07
Burdwan	·665	—·101	SE	9	273	0·11

The depression had developed slightly during the previous 24 hours, and marched rapidly westwards. The centre crossed the Orissa coast during the morning, and was between Cuttack, False Point, and Saugor Island at 10 A.M., and probably only a few miles to the north-east of Cuttack. The winds had increased very considerably at the more distant stations of Burdwan and Calcutta, but were very feeble near the centre, and more especially at Cuttack and Saugor Island. This is one of the many illustrations in these smaller cyclones of the small importance and irregularity of the air motion in the lowest atmospheric strata. Heavy rain was now falling in Orissa, and extending to the Central Provinces. The following table gives average rainfall data :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Orissa		14	2·15	5·23
Bengal	South-West Bengal	47	0·38	1·30
	East Bengal	24	0·15	0·62
Central Provinces	Nagpur	22	0·60	3·60
	Jubbulpore	22	0·36	3·60
	Nerbudda	21	1·46	3·25
	Chhattisgarh	15	0·96	5·49

13th September.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Khandwa	29·612	—·181	W	7	117	1·79
Amraoti	·605	—·190	WSW	3	68	0·43
Nagpur	·597	—·176	SW	7	152	2·44
Seoni	·568	—·199	SW	8	210	5·23
Hoshangabad	·501	—·206	WNW	2	67	3·77
Jubbulpore	·566	—·206	SE	6	167	0·58
Saugor	·596	—·223	E	4	133	0·25
Jhansi	·584	—·145	NE	5	167	*Nil.*

The depression had advanced rapidly through Orissa and the Central Provinces during the previous 24 hours. The Bombay current was established in force at this time in the Central Provinces, and had fed the cyclonic disturbance for the greater part of the day. It had in consequence intensified considerably. The depression had increased in amount, and the air circulation in the lower strata was more vigorous. The centre at 10 A.M. was near Hoshangabad in latitude 23° North and longitude 78° East. Light showers were falling in Bengal and Orissa, which gave an average of less than a third of an inch. Heavy rain was received in these districts of the Central Provinces through which it was passing. The rainfall in the southern quadrant was excessive compared with that of the northern quadrant. The following table gives the average amounts in the four divisions of the Central Provinces :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 A.M.
Central Provinces	Nagpur	24	1·76	3·90
	Jubbulpore	22	0·52	5·10
	Nerbudda	22	1·67	6·56
	Chhattisgarh	15	0·88	2·85

14th September.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Neemuch	29·556	—·231	SW	5	52	0·25
Indore	·665	—·137	S	8	148	1·49
Jeypur	·742	—·018	ESE	14	269	0·21
Ajmere	·598	—·159	NE	7	143	0·75
Deesa	·621	—·177	W	10	120	2 26
Surat	·715	—·118	W	7	77	1·93

The depression had advanced from the Central Provinces into Central India during the previous 24 hours. The centre was to the north-east of Neemuch in latitude 25 North and longitude 74½° East at 10 A.M. The depression was slightly greater than on the 13th. The westerly winds in the southerly quadrant were, however, now falling off in strength, and the rainfall was diffused over a larger area, and was less in amount than hitherto. The following gives the average and heaviest rainfalls in Bombay and Central India during the previous 24 hours. The heaviest rain occurred at Ahmedabad, 180 miles to the south-west of the centre at 10 A.M. of the 14th :—

Province.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bombay	52	0·71	4·25
Central India	18	0·18	1·49

The depression filled up rapidly during the afternoon and evening of the 14th, and there is no trace of its existence shown by the observations of the 15th.

One of its most important features was the rapidity of its march across the head of the peninsula. The following gives its position at 10 A.M. of each day, and its rate of motion:—

	Position.		Distance passed over on previous 24 hours.	Rate of motion in miles per hour.
	Latitude.	Longitude.		
12th September	20° 45′ N.	86° 15′ E.	...	...
13th „	23° 0′ N.	78° 0′ E.	560	23
14th „	25° 0′ N.	74° 30′ E.	270	11

(*No. XLV.*)—*Storm of October 2nd to the 9th.*—This was a small storm, generated at the commencement of the October transition period of 1881. It was rapidly formed near the coast of the Circars, and passed landwards in three days after its initiation. Hence it was of small intensity, and extended over a limited area. It marched westwards to the Eastern Ghats. The supply of vapour feeding it in the eastern quadrant was apparently large, as it passed northwards over the Orissa hills, through the Sambalpur District and Chutia Nagpur into Behar, where it filled up, after having given two days' heavy and general rain to the whole of Behar.

2nd October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·915	—·041	WSW	11	183	0·12
Port Blair	·883	—·044	SW	12	174	1·15
Akyab	·850	—·064	SSE	2	87	0·28
Chittagong	·846	—·075	E	2	62	...
False Point	·839	—·070	N	4	70	...
Vizagapatam	·838	—·060	W	1	48	...
Masulipatam	·821	—·089	SW	?	?	...
Madras	·850	—·060	W	6	118	0·64

The weather in Bengal on the 2nd was such as usually accompanies the formation of a cyclonic disturbance in the Bay. Pressure was very uniform over the north of the Bay and in Bengal, and the winds were very light and unsteady. Strong monsoon winds were blowing over the south-east of the Bay, and giving moderate rain to the Andamans and South Burmah. A few light local showers were falling in Bengal, more especially near the hills in North Bengal, but the total amount of rain was

small. The distribution of the rainfall at this time is given roughly by the following averages:—

Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall in 24 hours preceding 6 P.M.
South-West Bengal	47	0·07	0·68
North Bengal	25	0·43	1·77
East Bengal	24	0·03	0·50
Burmah	12	0·44	1·46

3rd October.

Station.	Barometer at 10 A.M. reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Port Blair	29·875	—·052	SW	12	174	0·90
Diamond Island	·868	—·055	S	5	75	0·32
Akyab	·841	—·073	SE	4	174	...
Chittagong	·835	—·086	ENE	3	94	0·15
Saugor Island	·808	—·090	ENE	4	64	0·68
False Point	·802	—·107	N	5	88	0·10
Cuttack	·801	—·112	Calm	P	P	...
Vizagapatam	·802	—·096	W	1	48	...
Masulipatam	·809	—·101	Calm	P	P	...
Madras	·857	—·053	WSW	4	78	0·01

The barometer was now falling generally, and the fall was greatest at the north-west coast stations of the Bay. The wind directions indicate that feeble cyclonic motion was now established over the north of the Bay, and that moderately strong humid south-west winds were blowing in the easterly quadrant. The conditions were unchanged in Bengal.

Pressure was remarkably uniform over Northern and Central India, and winds were very light. Calms were recorded at a large number of stations in Bengal, Orissa, and the North-West and Central Provinces. The rainfall was much smaller in amount than on the 2nd, as is shown by the following averages:—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall in 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·13	1·20
	North Bengal	25	0·17	1·27
	East Bengal	24	0·06	0·60
Burmah		12	0·30	0·90

4th October.

Station.	Barometer at 10 A.M., reduced to sea-level	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·905	—·051	WSW	12	200	0·05
Port Blair	·852	—·075	SW	11	160	0·43
Diamond Island	·870	—·053	SSE	3	45	0·36
Akyab	·835	—·079	SSE	3	130	...
Saugor Island	·806	—·092	NE	11	177	2·25
False Point	·774	—·135	NNW	15	263	0·55
Cuttack	·768	—·145	SE	2	111	0·74
Sambalpur	·723	—·172	NW	0	...	...
Sironcha	·829	—·114	NNW	4	143	0·38
Secunderabad	·867	—·078	E	11	324	...
Vizagapatam	·716	—·182	WNW	2	100	0·20
Masulipatam	·771	—·139	WNW	P	P	...

A considerable fall of the barometer had occurred at the west coast stations during the previous 24 hours. There was now a distinctly marked depression off the coast of the Circars, or between False Point and Masulipatam. Winds had strengthened very considerably at all the coast stations, and were generally above their normal force in South Bengal and Orissa. Rain was now falling in moderately large amounts over the coast area from Saugor Island southwards to Vizagapatam. The following gives the average rainfall in Bengal during the previous 24 hours:—

Division.	Number of stations.	Average rainfall of previous 24 hours.	Heaviest rainfall during previous 24 hours.
South-West Bengal	47	0·73	3·07
East Bengal	24	0·36	1·71
North Bengal	25	0·36	3·63
Burmah	17	0·12	0·43

Rainfalls exceeding one inch occurred during the previous 24 hours at the following stations in the Madras Presidency, all of which are in the Northern Circars:—

	Inches.
Vizianagram	7·00
Bimlipatam	4·80
Aska	4·50
Ganjam	2·80
Gopalpore	1·87

5th October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
False Point	29·766	—·143	E	9	158	0·02
Cuttack	·750	—·163	ESE	2	111	0·12
Sambalpur	·744	—·151	NE	1	62	...
Sironcha	·767	—·176	NNW	4	143	0·03
Secunderabad	·877	—·068	NW	15	441	...
Vizagapatam	·554	—·344	W	7	333	3·10

The observations of the 5th show that a depression of considerable intensity was approaching the coast to the north of Vizagapatam. The depression was of moderate extent, but winds of considerable force obtained at distances of 150 to 200 miles distance from the centre. The rainfall in Bengal, Orissa, and the Central Provinces was small in amount. Heavy rain was falling over the coast area to which the depression was advancing. The following table indicates the distribution of rainfall at this time in Bengal and the Central Provinces :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall in 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·36	1·60
	North Bengal	25	0·10	0·80
	East Bengal	24	0·16	1·00
Central Provinces	Nagpur	20	0·07	0·70
	Jubbulpore	22	*Nil*	...
	Nerbudda	22	*Nil*	...
	Chhattisgarh	15	0·07	0·56

The following rainfalls, exceeding one inch, were registered in the Madras Presidency :—

	Inches.		Inches.
Koraput	6·00	Vizianagram	2·50
Vizagapatam	3·30	Gopalpore	2·22
Aska	2·90	Kotipad	2·30
Gunipur	2·75		

All these stations are in the Northern Circars and to the north of Vizagapatam.

6th October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
False Point	29·708	−·206	SSE	11	193	0·70
Cuttack	·712	−·201	E	1	56	0·42
Sambalpur	·630	−·265	NE	3	187	2·37
Raipur	·844	−·091	NE	8	229	0·68
Sironcha	·740	−·203	N	6	214	0·33
Secunderabad	·833	−·122	W	14	412	...
Vizagapatam	·655	−·243	W	7	333	0·60

The centre of the depression had crossed the coast during the previous 24 hours, and was between Vizagapatam, Sambalpur, and Cuttack at 10 A.M., and probably advancing almost due northwards across the South Orissa hills. Very strong winds were blowing in the southern quadrant. The wind observations show that the cyclonic circulation was fully maintained at this time, and extended westwards over a large portion of the Central Provinces. Little or no rain was falling in Bengal or the Central Provinces, and the rainfall in the northern districts of the Madras Presidency was much less in amount than during the preceding two days. The depression diminished rapidly during the day, but continued to advance northwards. The following table gives the average rainfall in Bengal and the Central Provinces during the previous 24 hours :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall in 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·25	1·84
	North Bengal	25	0·01	0·22
	East Bengal	24	0·15	1·51
Orissa	...	14	1·68	4·00
Central Provinces	Nagpur	20	*Nil*	...
	Jubbulpore	22	*Nil*	...
	Nerbudda	22	*Nil*	...
	Chhattisgarh	15	0·55	·245

The only rainfalls exceeding one inch in the Madras Presidency for the 6th were the following :—

	Inches.
Gunipur	2·90
Nowrangapur	2·00
Gopalpore	1·34

7th October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Jubbulpore	29·779	—·169	N	3	130	...
Raipur	·781	—·137	NW	13	167	0·29
Sambalpur	·662	—·233	SW	3	188	5·95
Cuttack	·701	—·212	WSW	1	56	0·75
Calcutta	·757	—·155	SE	3	91	0·19
Hazaribagh	·704	—·216	SE	9	180	0·90
Patna	·728	—·191	E	4	211	2·30

The depression had advanced northwards, and, although a comparatively shallow one, it covered a considerable area. The centre had crossed the Orissa hills into the eastern districts of the Central Provinces, and was now advancing through the Sambalpur district into Chutia Nagpur. Large quantities of vapour and cloud were brought up by moderately strong winds from the Bay, and rain was falling chiefly in Chutia Nagpur and Behar, in front of the advancing depression. The following table gives the distribution of rainfall for the previous 24 hours :—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·46	2·50
	North Bengal	25	0·41	2·26
	East Bengal	24	0·11	0·60
Behar	South Behar	23	1·81	6·56
	North Behar	17	1·95	5·70
Orissa	...	14	0·88	2·40
Chutia Nagpur	...	10	1·19	6·55
Central Provinces	Nagpur	24	...	0·10
	Jubbulpore	22	*Nil*	*Nil.*
	Nerbudda	22	*Nil*	*Nil.*
	Chhattisgarh	16	0·59	5·50

8th October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Hazaribagh	29·770	—·150	W	10	200	0·77
Berhampore	·800	—·128	SE	4	191	0·23
Purneah	·775	—·143	NE	5	333	2·57
Durbhanga	·810	—·112	ENE	10	500	2·79
Patna	·764	—·155	E	11	579	1·80
Gya	·798	—·131	W	5	250	2·25

The depression had filled up partially during the previous 24 hours. It was now a shallow one, although it covered a considerable area, including the whole of Behar, and Chutia Nagpur, and the adjacent districts. The centre of the cyclonic circulation was between Gya and Patna, and unusually strong winds were blowing at all stations in the northern quadrant. Heavy rain continued to fall in Behar, and moderate rain was being received in North Bengal. Elsewhere the amounts were small, as is shown by the following average rainfall data:—

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·41	1·36
	North Bengal	25	0·82	4·00
	East Bengal	24	0·04	0·44
Behar	South Behar	23	1·58	5·10
	North Behar	17	1·77	3·68
Orissa		14	0·09	0·50
Chutia Nagpur		10	0·17	0·90

9th October.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in previous 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Saugor Island	29·766	—·132	NW	9	145	0·19
Berhampore	·797	—·131	Calm	2	95	1·30
Purneah	·798	—·120	NE	3	200	1·30
Durbhanga	·800	—·122	ENE	1	50	1·25
Patna	·818	—·101	NE	2	105	...
Hazaribagh	·820	—·100	Calm	4	80	...

The depression occupied almost exactly the same position and the deficiency of pressure was almost as large in amount as on the 8th. Winds had, however, diminished very rapidly in force, and were at 10 A.M. below their normal strength. The rainfall of the preceding 24 hours was small in amount in Behar, as compared with that of the 7th and 8th. The following averages indicate its distribution:—

9th October.

Province.	Division.	Number of stations.	Average rainfall of 24 hours preceding 6 P.M.	Heaviest rainfall of 24 hours preceding 6 P.M.
Bengal	South-West Bengal	47	0·76	3·14
	North Bengal	25	0·62	6·35
	East Bengal	24	0·21	1·79
Behar	South Behar	23	0·33	3·96
	North Behar	17	0·31	0·80
Orissa		14	0·04	0·35
Chutia Nagpur		10	*Nil.*	*Nil.*

The depression and cyclonic circulations disappeared during the afternoon of the 9th. Fine weather, with clear skies and light winds, obtained over the whole of Behar and the greater part of Bengal on the morning of the 10th.

(*No. XLVI.*)—*Storm of November 10th to the 13th.*—This was a small storm, that was generated during a break in the rains of the north-east monsoon in the Madras Presidency which commenced in the second week of November. Strong winds continued to bring up much vapour and rain to Ceylon and the south of the Bay, which, instead of being carried westwards, and deposited in Southern India, fell over the south of the Bay. A small depression was speedily formed to the east-north-east of Trincomalee, and advanced north-west to the Coromandel coast, which it crossed near Madras. It gave moderately heavy rain to the coast districts near Madras, but speedily broke up as it advanced westwards to the higher and broken ground of Mysore. Its existence was first indicated by the observations of the 10th given in the following table:—

10th November.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·857	—·103	SSE	11	204	0·30
Port Blair	·869	—·089	SE	14	192	2·45
Diamond Island	·893	—·074	NNE	7	84	...
Vizagapatam	·947	—·074	NE	1	40	...
Masulipatam	·915	—·093	E	?	?	...
Madras	·908	—·083	N	7	103	...
Negapatam	·908	—·057	NW	8	143	0·35
Trincomalee	·857	—·094	NNW	7	104	1·85
Galle	·907	—·032	NW	5	147	0·67
Colombo	·916	—·033	NW	8	148	3·45

The preceding observations show that there was slight general depression near the south of the Bay, extending from the Nicobars to the East Ceylon coast. Strong humid winds prevailed at the entrance and over the south-east of the Bay, and were giving heavy rain in Ceylon, and at the Andamans and Nicobars. Very little rain was falling in the Madras Presidency, and winds were very light on the coast to the north of Madras. No rain was falling in Bengal at this time.

11th November.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·862	—·098	SSW	5	93	0·29
Port Blair	·897	—·061	SE	17	233	0·54
Diamond Island	·950	—·017	E	11	132	...
Vizagapatam	·926	—·095	E	2	80	...

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Masulipatam	29·903	—·105	NNE	?	?	...
Madras	·856	—·135	N	8	118	...
Negapatam	·837	—·128	NNW	6	107	...
Trincomalee	·789	—·162	NNW	11	164	0·33
Galle	·900	—·039	NNW	9	265	4·98
Colombo	·908	—·041	WNW	10	185	6·08

A small but well-marked depression was now established to the north-east of Trincomalee, and was travelling to the north-north-west or north-west. Unusually strong winds prevailed on the Ceylon coast, and were giving very heavy rain. The conditions were generally unchanged over the north and east of the Bay, except that the winds were diminishing in strength, and the rainfall decreasing in amount at the Nicobars and Andamans. No rain was received in Bengal during the previous 24 hours, and only a few light showers of no importance in Southern India. Rainfall was at this time confined to Ceylon and the south of the Bay.

12th November.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·945	—·015	SSW	6	111	0·13
Port Blair	·909	—·049	SE	11	151	0·49
Diamond Island	·966	—·001	ENE	12	145	...
Vizagapatam	·918	—·103	NE	4	160	...
Masulipatam	·835	—·173	NE	?	?	0·01
Madras	·780	—·211	NW	15	221	1·95
Negapatam	·804	—·161	W	7	125	0·28
Trincomalee	·771	—·180	SW	14	209	0·34
Galle	·847	—·092	W	11	323	0·46
Colombo	·852	—·097	WSW	13	240	2·73

The depression had intensified slightly during the preceding 24 hours, and travelled to the north-west. The centre at 10 A.M. was a little distance to the east or east-north-east of Madras. Very strong winds prevailed on the Ceylon and Coromandel coasts. The rainfall was diminishing in Ceylon with the northward advance of the

depression. On the other hand, rain began to fall at 10 A.M. in moderate amounts on the Madras coast, and increased in intensity during the remainder of the day. The following amounts exceeding one inch were registered at 6 P.M. :—

	Inches.
Madras	8·19
Arcot	3·55
Cuddapah	3·20
Chingleput	2·45
Saidapet	2·20
Conjeveram	1·50
Salem	1·33

The heavy rainfall was hence almost confined to the coast districts in the neighbourhood of Madras.

13th November.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·936	—·024	SSW	2	37	0·05
Port Blair	·893	—·065	SE	5	68	0·43
Vizagapatam	·935	—·086	NE	4	160	...
Masulipatam	·882	—·126	NE	?	?	0·31
Madras	·797	—·194	SSE	23	338	6·24
Secunderabad	·979	—·062	NE	?	?	...
Bellary	·911	—·091	NNW	9	281	0·40
Bangalore	·876	—·110	WSW	6	171	1·77
Negapatam	·827	—·138	W	18	321	0·43
Trincomalee	·853	—·098	NNW	13	194	...

The depression had crossed the coast north of Madras on the previous day, probably late in the afternoon. It had commenced to fill up, and the air motion in its neighbourhood was less regular, and indicated the speedy disintegration of the vortex. Strong winds had prevailed over the area of depression during the previous 24 hours, but they decreased very rapidly in strength during the 13th. Moderately heavy rain fell over the greater part of the Madras Presidency. The largest amounts were received at Madras and the neighbouring stations. The following gives the falls exceeding 2 inches :—

	Inches.
Saidapet	5·22
Vellore	3·60
Chingleput	3·32
Conjeveram	2·70
Nellore	2·60
Madras	6·24

14th November.

Station.	Barometer at 10 A.M., reduced to sea-level.	Difference from normal.	Wind.			Rainfall in past 24 hours.
			Direction at 10 A.M.	Velocity in miles per hour for the preceding 24 hours.	Ratio of amount of wind to average amount expressed as a percentage.	
Nancowry	29·929	—·031	NNE	2	37	...
Port Blair	·896	—·062	W	5	68	...
Vizagapatam	·967	—·054	N	1	40	0·10
Masulipatam	·925	—·083	NNE	?	?	0·24
Madras	·923	—·068	SE	4	59	6·12
Secunderabad	·987	—·054	E	?	?	0·07
Bellary	·964	—·038	SE	5	156	0·06
Bangalore	·923	—·063	ESE	2	57	0·01
Negapatam	·878	—·087	S	4	71	...
Trincomalee	·870	—·081	WSW	2	30	0·14
Belgaum	·922	—·079	E	6	146	0·21
Mercara	·862	—·102	E	3	70	0·13

The observations of the 14th show that the cyclonic circulation had completely disappeared, and that light winds were established before 10 A.M. over the whole of the south of the Bay, and the greater part of Southern India. Light showers had fallen at the majority of stations in the Madras Presidency during the previous 24 hours, but the total amounts received were in all cases small. Only two stations (*viz.*, Madras and Chittore) reported a rainfall exceeding eight tenths of an inch. The disturbance thus broke up on the evening of the 13th.

The following are the more important and characteristic features of the distribution of the storms of the year 1881:—

1st.—The earliest storm of the season was formed late in May at the end of the hot-weather transition period near the head of the Bay.

2nd.—The storms of the south-west monsoon period proper all formed at the head of the Bay and passed across the coast of the north-west angle of the Bay to the north of False Point.

3rd.—Two storms passed across the head of the peninsula into Western India. They advanced with unusual rapidity, their average motion when crossing the continent exceeding 20 miles per hour.

4th.—No storm crossed the Burmah or Aracan coast during the year.

5th.—In other respects the distribution was approximately normal.

General Review.

The preceding portion of this paper has given a list and a brief account of a large number of storms which originated in the Bay of Bengal and passed landwards during the five years, 1877–81.

It establishes fully that cyclonic storms, or disturbances, are a regular and frequent feature of the whole south-west monsoon period. They are, moreover, of all degrees of intensity. The chief difficulty in drawing up the list of storms was found to arise from the fact that atmospheric eddies, or whirls, of all degrees of intensity and magnitude pass up from the Bay to the coast districts or interior of India during the rains. The selection is hence to a certain extent arbitrary. It, however, includes all the more important storms as defined by an existence of the cyclonic circulation on land for a period exceeding 24 hours. If it had been desirable, a large number of smaller whirls could have been included. It appears in fact, as might have been expected, that the frequent advances of strong humid winds, which occur in rapid succession during the rains (and are separated by intervals of light winds and local rain showers), are always accompanied by much eddying motion in front, which tends to accumulate and give rise to cyclonic disturbance on the large scale. Hence, apparently, it is, that whirls of all degrees of intensity and magnitude may occur at any time during the period of partial or complete prevalence of south-west monsoon winds over the Bay. Although these storms differ in their minor features, they resemble each other in all their more important characteristics, as cyclonic air-motion on the large scale, and can be differentiated only with respect to their magnitude. They are, all, therefore, phenomena of the same general class in the meteorology of the Indian land and sea areas.

The preceding account of the storms has clearly indicated, that what may be termed the prevalence of steady south-west winds, giving continuous general rain over the land area of Northern India for more than a few days, is an event of comparatively rare occurrence. The atmospheric actions during the south-west monsoon are intermittent or oscillatory in character to a very marked extent. A decrease in the monsoon current, as a rain-giving air current, is shown, not merely by a decrease in the strength of the winds and of the amount of rain, but frequently, if not usually, by a gradual and slight retreat of the humid southerly winds southwards, and their replacement by light local, and variable winds in the Gangetic Plain and Bengal. The rainfall during these intervals or breaks in the rains is not only limited in amount, but occurs as local showers over small areas, and is different in character from the general rain which accompanies a large influx of vapour and cloud during a strong burst of monsoon winds. These intervals of partial and limited rainfall are each followed by a fresh advance of the monsoon current up the north of the Bay into Bengal. They are preceded by conditions similar in character to those which usher in the first establishment of the south-west monsoon, but are less strongly marked. The atmospheric actions which accompany the advance are also similar in character. The southerly winds press forwards up the north of the Bay. Heavy rain occurs over the northern limits of the advancing winds, where there is much irregular eddying motion and disturbance, shown chiefly by the frequent occurrence of rain and wind squalls. Frequently, the conditions are favourable to the accu-

mulation of rotatory motion on the large scale, and a considerable cyclonic disturbance is formed in front of the advancing massive winds, and is impelled forward by the weight of southerly winds in the rear along the line of least resistance in front. Following in the rear of the cyclonic disturbance is a strong southerly atmospheric current, which advances with it, and brings up the large supplies of vapour which feed and maintain the cyclonic circulation, and also give general rain to the districts over which it marches for some time after the passage or disappearance of the vortex. The diminution in strength of the south-west monsoon winds in Bengal and at the head of the Bay, and of the amount of rain in North-Eastern India, accompanies a marked decrease in the baric gradients over the Bay. During a break in the rains, the barometer, although it oscillates to some extent, remains generally high and above the average. Pressure apparently first gives way to a marked extent, over the northern portion of the area of southerly winds in the Bay, when they begin to advance, and rain squalls commence and increase in frequency and intensity. The depression increases and extends northwards, and also influences the barometer at distances considerably beyond the area, or limits, of squally or stormy weather. Hence a falling barometer precedes the advance of these depressions, but the fall is not large, except near the central depression. It, therefore, appears probable, if not certain, that the northward extension of these southerly winds and the generation of the accompanying storms (as problems of air-motion) are not to be primarily explained by meteorological conditions in the interior of India, but that they are due mainly to actions and changes in the current itself. In other words, it is the self-contained potential energy (of change of state) of the current itself, which by its conversion into kinetic energy of the mass of air, gives rise to the phenomena. The differences of condition, as measured by the baric gradients, although doubtless influential, are not the most important factor. This is a point which has not yet received full consideration. It is only necessary in this brief sketch to indicate the probability that, after the primary establishment of the monsoon current, the chief factor in maintaining, renewing, or extending it during the monsoon months, is the transfer of energy to the atmosphere which accompanies rainfall, and occurs during the process of condensation.

The history of these storms appears to show the great importance of rainfall as a meteorological factor. It is the one prominent and invariable feature in all the large atmospheric disturbances in India. The study of the meteorology of India, during the past ten years, has shown that cyclonic disturbances or storms have originated in the Bay during the prevalence of relatively high pressure in Northern India, and also of low pressure. They have formed during the continuance of south-west monsoon conditions, and also of north-east monsoon conditions in Northern India. They have been initiated during strong south-west monsoon winds on the Bombay coast, and also during the prevalence of light unsteady monsoon winds. They have been generated during the existence of south-west monsoon storms in Western India, giving violent winds and excessive rain to the Bombay coast districts. They have also been formed during the existence of cyclonic disturbances in Upper India, due to cold weather or north-east monsoon actions and conditions. In fact, they have apparently been initiated during the prevalence of every possible variety and combination of meteorological conditions on the large scale in Northern and Western India. The important conclusion follows that

the generation and motion of cyclones in the Bay of Bengal is chiefly, if not entirely, due to conditions and actions over the initial area of disturbance in the Bay, and not to conditions in distant regions.

It appears to be conclusively established that a much smaller number of cyclonic disturbances form in the Arabian Sea, and pass across the west coast of India than advance from the Bay to its coasts. This is undoubtedly due to the peculiar shape of the Bay of Bengal, and to the geographical features of the coast districts. It is important to note the full significance of this fact. There is no doubt that, of the two branches of the south-west monsoon current, the Bombay branch, when crossing the Bombay coast, is nearly twice as strong (as measured by the average force of the winds) as the Bay of Bengal current at the head of the Bay. Notwithstanding this difference, there is not a single case on record of a fully developed cyclonic storm having originated in the Arabian Sea, and advanced across the Bombay coast and marched through Central or Northern India into Bengal or the Bay of Bengal. The present paper describes several vortices which drifted completely across the head of the peninsula, and disappeared near or in the Arabian Sea. The Bay of Bengal, from its position with respect to the equator, its peculiar shape, the direction and elevation of the line of hills in Burmah and Arakan, which deflect the monsoon winds near the head of the Bay, is almost, if not quite, a perfectly self-contained meteorological area so far as the generation of cyclonic storms is concerned. In it, the problem of storm generation under tropical conditions on a moderate scale, is worked out from the initial stage.

The preceding discussion has, to a certain extent, indicated the prevalence of certain common and invariable meteorological conditions in a portion or the whole of the Bay and the adjacent coast districts, immediately antecedent to the formation and advance of cyclones in the Bay. The storms under discussion were all, without exception, generated during the prevalence of south-west monsoon conditions over the whole or a part of the Bay, and after more or less prolonged breaks in the rains, due to the south-west monsoon. Each storm brought up humid winds to the coast districts, and was followed by more or less general bursts of rainfall to large land areas after its passage inland.

It will be sufficient to indicate briefly the conditions which obtain during a break in the rains of the south-west monsoon, and which frequently, if not invariably, precede and accompany the formation of the cyclonic disturbances of the Bay—

1st.—The baric gradients over the Bay and in Northern India decrease for some time before the formation of the storms. This is generally shown most strongly in the north of the Bay. The tendency of such a change is to give approximate uniformity of pressure, over the whole or a portion of the Bay area and the adjacent coast districts. The position of the absolute minimum pressure in the Indian area at such periods appears to depend partly upon previous meteorological actions and local conditions, and bears no general relation to the area in which the subsequent cyclonic disturbance is generated.

2nd.—The winds decrease in strength, and the general monsoon circulation becomes feeble; more especially at its northern limits. Hence, over the coast districts of the Bay, and the northern portions of the Bay, which are just beyond the limits of the persistent south-west winds, the air-motion is

feeble, variable, and local in character, and such as usually accompanies approximate uniformity of pressure distribution. This condition, when taken in connection with the uniformity of temperature and humidity conditions of the Bay and the adjacent coast districts, is directly and necessarily related to the preceding condition of approximate uniformity of pressure conditions.

3rd.—The temperature and humidity conditions in the Bay and adjacent coast districts are generally very uniform during the whole of the south-west monsoon proper; and also, to a slightly less extent, in the May and October transition periods. This feature is usually most pronounced during breaks in the rains.

4th.—If the break in the rains is more or less prolonged, the skies are usually clear, the sea smooth, and weather hot and sultry over the north of the Bay.

The most prominent feature in the cyclones of the Bay is the prevalence, during their initiation and existence, of strong humid southerly winds, which bring up large quantities of aqueous vapour from the evaporating area of the Indian Ocean. Aqueous vapour condensation always proceeds rapidly during the cyclone, and gives excessive rainfall, the distribution of which, during the storm, has the characteristic of being more or less localized and concentrated. It occurs mainly over the area of depression; and, to a less extent, over the whole area in which the southerly winds obtain. The energy set free during the act of condensation, is transferred to the atmosphere, and supplies the motive power which initiates and maintains the large atmospheric motion of the cyclonic disturbance. The energy thus set free is, it may be remarked, transferred rapidly and continuously in large amounts, more than sufficient to account for the vast accumulation of motion embodied in any cyclone, and to enable it to overcome the resistances it encounters in its line of march. Hence, considered from this point of view, cyclonic storms on the large scale may occur in the Bay, at any time during the period when a massive southerly current enters from the Indian Ocean, and extends over a considerable portion or the whole of the Bay, that is, during the prevalence of the south-west monsoon over the whole or a part of the Bay. The south-west monsoon winds usually enter the Bay first, in the beginning of May, and are generally fully established before the end of May or first week of June. They continue in full average strength, (although intermittent and oscillatory in character,) during the months of June, July, and August, and diminish in force somewhat rapidly in September. The decrease in strength is manifested chiefly in two ways, first by the occurrence of longer intervals between successive bursts of humid winds and general rain, and, secondly, by the tendency of the current to recurve, not in Bengal, but further south in the north or centre of the Bay, so that the strong winds are not impelled so far north as previously. This gradual average retreat of the northward limit of the humid winds of the south-west monsoon proceeds more rapidly in October and November. During these months, the northern limit of the winds is transferred southwards, the winds in the lower strata recurve near the northern limit, and are usually continued to the Ganjam and Coromandel coasts, to which they give frequent bursts of rain, which are occasionally preceded and accompanied by cyclonic storms. South-west monsoon winds are usually finally displaced from the Bay before the 15th of December. Hence, cyclonic disturbances on the large scale, of varying intensity, depending partly upon

the antecedent meteorological conditions in the Bay and partly upon the strength of the humid current advancing up the Bay, may occur at any time between the beginning of May and the middle of December. If they originate before the 1st May or after the 15th December, they are due to very abnormal combinations of meteorological conditions. Of the forty-six storms which are described in the preceding pages, and which, it is believed, include all the cyclonic disturbances of sufficient magnitude as to reach land and continue unbroken, and present the ordinary phenomena of a cyclonic circulation on the large scale for a period of at least 24 hours after reaching land, during the five years 1877–81, not one was formed in the interval from the 15th December to the 1st of May.

The whole period from 1st May to 15th December in its relation to storm occurrence may be divided into three periods—

1. From the 1st to 31st May, which may be termed the May, or hot-weather, transition period. During this interval, the monsoon winds advance and gradually establish themselves over the Bay, and initiate that large and massive change over the Indian land area known as the setting-in of the rains.
2. From the 1st June to 30th September, during which south-west monsoon winds of varying intensity are permanently established over the whole of the Bay, and give general rain to the whole of North-Eastern India. This might be termed the intermediate period, or south-west monsoon proper.
3. From 1st October to the 15th of December, during which the south-west monsoon winds gradually cover a smaller portion of the Bay, and their northern limit retreats southward. The winds in the lower strata recurve in the centre of the Bay, and are continued to the west or Madras coast. This interval might, perhaps, be termed the October, or cold-weather, transition period.

It is of some importance to note that the second, or October transition period (characterized by increasing weakness of the monsoon current) is much longer than the May period, when the south-west monsoon winds are impelled forward by vigorous forces. The conditions which obtain during these three periods differ considerably, and thus influence the number and character of their cyclonic disturbances.

The following table gives the number of cyclonic storms during these periods in each of the five years 1877-81 :—

	Length of period.	1877.	1878.	1879.	1880.	1881.	Total.	Yearly.
May 1st—31st . . .	One month . .	1	0	2	1	1	5	1
June 1st—September 30th .	Four months . .	6	5	3	6	8	28	5·6
October 1st—December 15th .	Two-and-a-half months .	1	4	4	2	2	13	2·6

Taking the same unit of time,—one month,—the above shows that, in the transitional periods, storms of the standard adopted occur at the rate of one per mensem, and in the intermediate period, or south-west monsoon proper, at the rate of nearly three in two months, or one and a half per month. Hence, the probability of storms, during the rains proper, is to that of the transition periods, in the ratio of 3 : 2 nearly.

A second feature of storms, of equal importance to their frequency of occurrence, is their intensity. The best measure would, undoubtedly, be the strength of the winds.

Anemometric observations at different stations are seldom intercomparable. The amount of wind registered by the anemometers in use depends very largely upon their situation and exposure, and this is, in Indian stations, which are always more or less crowded with large trees, more or less unsatisfactory. The least objectionable measure is hence the barometric depression at the centre. The standard of reference in India ought to be the normal pressure at the centre, at the time, as determined from the observations of a period of not less than 10 years. In the present paper, the mean pressure of the month has been employed, as daily means have not yet been obtained for our Indian stations, except in some special cases. The difference between the amount of the depression, as derived from the monthly means, and that which would be obtained by the employment of the daily means, might occasionally amount to five or six hundredths in excess or defect, according as the storm occurred at the beginning or end of a month. A storm of small intensity will be defined as one in which the central depression, as measured by the barometer, is less than half an inch, and a storm of a considerable, or great, intensity as one in which it exceeds half an inch.

It will be seen that the storms which occurred in the Bay during the quinquennial period, 1877–81, were almost, without exception, of comparatively small extent and intensity. A reference to Mr. Blanford's list of cyclones, or the various cyclonic reports, published by the Bengal Meteorological Department, will establish that the most intense cyclones occur in the Bay rarely and at long intervals. Not one of the storms under discussion was comparable with the Calcutta cyclone of 1864, or the Backergunge cyclone of 1876. The difference, however, is wholly one of degree, and not of character.

The following list divides the storms of the three periods into two classes, according as the central barometric depression was greater or less than half an inch. The division is based on the whole of the observations on land and at sea which have been received in the Bengal Meteorological Office—

	1877.		1878.		1879.		1880.		1881.		Total.	
	Number of storms in which the depression was											
	Greater than half an inch.	Less than half an inch.	Greater than half an inch.	Less than half an inch.	Greater than half an inch.	Less than half an inch.	Greater than half an inch.	Less than half an inch.	Greater than half an inch.	Less than half an inch.	Greater than half an inch.	Less than half an inch.
May transition period . . .	1	...	...	...	1	1	...	1	...	1	2	3
Intermediate period . . .	...	6	...	5	...	3	...	6	...	8	...	28
October transition period . .	...	1	2	2	...	4	1	1	...	2	3	10

The following are the storms in which the central depression is known to have exceeded half an inch :—

No.	I.	Cyclone of May . .	1877	No.	XVIII.	Cyclone of May . .	1879
„	XVI.	„ November . .	1878	„	XXXV.	„ November .	1880
„	XVII.	„ December . .	1878				

The period taken for consideration is too brief, and the number of storms too small to admit of the induction of approximately accurate laws of the distribution of cyclones

in the Bay according to intensity. It may, however, be inferred that cyclonic storms are most frequent, but least intense and severe, during the intermediate period, or south-west monsoon proper, and that the central depression rarely, if ever, exceeds half an inch. Cyclonic disturbances of considerable intensity occasionally occur during the transition periods. The figures appear to indicate that one such storm is likely to occur every year during the May transition period, and two every year during the October transition period; and, if we take the length of the period into consideration, they are, proportionately to the time, very slightly more frequent in the October than in the May transition period. The storms of the transition periods vary in intensity between much wider limits than those of the intermediate period, and under rare combinations of conditions, cyclones of the most extensive and violent character may occur during these two periods. They are then amongst the most violent and energetic atmospheric disturbances with which we are acquainted.

The cyclones of the quinquennial period 1877–81 are arranged in the following table according to the part of the coast which they crossed. The Burmah coast is assumed to extend north as far as Akyab, the Bengal coast from Akyab to the mouth of the Hooghly, the Orissa coast from the mouth of the Hooghly to the Chilka Lake in South Orissa, the Ganjam coast from the Chilka Lake to Vizagapatam, the coast of the Circars from Vizagapatam to Masulipatam, and the Coromandel coast from Masulipatam southwards.

Month.	Number of cyclones during the quinquennial period 1877-81 the centres of which crossed the					
	Burmah Coast.	Bengal Coast.	Orissa Coast.	Ganjam Coast.	Circars Coast.	South Coromandel Coast.
May	...	2	1	...	...	2
June	...	1	3	...	...	...
July	...	1	3	1	...	...
August	...	3	8	...	...	...
September	...	2	5	1	...	...
October	...	1	1	1	3	...
November	2	...	...	...	1	3
December	...	...	...	...	1	...
Total	2	10	21	3	5	5

These figures speak for themselves, and it is only necessary to point out the very large proportion (roughly one-half) of storms which crossed the Orissa coast.

The distribution of cyclones presents very great differences from year to year, and appears to be intimately related to the larger abnormal features of the distribution of pressure and of the air-motion during the monsoon period. These relations can at present be merely indicated. Their determination will require the consideration of the storms of a much longer period than those discussed in the present paper. A cursory examination of the storm charts of the years 1877-81, given at the end of the report, will show the more striking differences between the distribution of the storms of these years, and also the features common to the storms of each year.

In the year 1877, there were eight cyclonic storms, which have been described in the preceding pages. Four of these crossed the Bengal coast, and seven of them advanced into Bengal or Behar, and were disintegrated in the northern districts of the Province of Bengal. Only one storm crossed the Orissa hills and passed into the Central Provinces. It was pointed out in the brief history of the meteorological peculiarities of the year 1877, that its chief features were excessive pressure in Western and North-Western India and deficient pressure in North-Eastern India. The rains were very deficient in Upper India, and the Bengal branch of the monsoon current advanced beyond Behar only at distant intervals. Hence, there was unusually little interaction between the two currents at the head of the peninsula, and the cyclonic storms of the year marched almost exclusively northwards into Bengal, the area of permanently deficient pressure during the season.

The distribution of storms in the year 1878 was almost the reverse of that of the preceding year. Nine storms, in all, passed from the Bay into the interior. One only of these advanced across the Bengal coast into Bengal. The remaining eight storms crossed the north-west coast between Chandbally and Masulipatam. The earlier storms showed a marked tendency to march across the head of the peninsula (*vide* Plate XXIII). One advanced in July into Upper Sind, a second in August to Bundelkhand, and a third in September into Gujarat and Cutch. The four storms of the cold-weather transition period marched along similar paths, and struck the same part of the coast near Vizagapatam. The peculiar conditions, which apparently determined this repetition, have been given in a separate discussion (pages 440–442). A reference to the abnormal features of the year 1878, and more especially those of the monsoon period, will show that they were, roughly speaking, also the opposite of those of the preceding year. Pressure was deficient in Western India, and in excess in North-Eastern India. The Bombay branch of the monsoon current was very vigorous and gave abundant rain. The Bay of Bengal branch was weak, as judged by the rainfall it gave to Arakan, Bengal, and Assam. The cyclonic storms were hence formed generally further south than usual, and moved to the westward towards the area of deficient pressure, and avoided the area of excessive pressure.

The storms of 1879 were much more equally distributed, both as to locality and time. One passed into Burmah, two into Bengal and Behar, four across the Central Provinces into Rajputana or Central India, and two into Madras. The brief history of the abnormal features of the year shows that they were much smaller in amount and less marked than in 1877 and 1878. The Bombay current was somewhat weak, late in being established, and gave little rain in the Punjab and the greater part of Rajputana. The line of junction of the two currents was absent in July, and stretched from Orissa to Sutna in August and September. An inspection of the storm chart for the year (Plate XXIV) will show how closely these conditions are connected with the storms of the intermediate period. No storm passed westwards in July. One passed westwards in August across Sutna, and the third near the end of September, further to the south, into Central India. The chief feature of the year was the local deficiency of pressure in Arakan and the adjacent portion of the Bay. It was intensified during the latter months of the rains. An unusually large number of storms hence originated in the immediate neighbourhood of the Akyab coast. Their connection with the peculiar meteorological conditions is discussed in pages 442–4.

The distribution of the storms of the year 1880 resembled that of 1879 more than that of 1878 or that of 1877. Nine storms are discussed in the body of the report. Two passed into Behar and Western Bengal. Six advanced across the Orissa coast into the Central and North-West Provinces, and one into the southern districts of the Madras Presidency. Three of the six storms which crossed the Orissa coast advanced westward beyond the Central Provinces. One broke up in Western Rajputana, a second in the western districts of the North-Western Provinces, and the third in Bundelkhand. The storms all appear to have formed in the neighbourhood of the west coast of the Bay, and hence contrast, in this respect, strongly with those of the year 1879, when there was a marked tendency to their formation near the Arakan coast. The larger abnormal features of the meteorology of the year are stated in pages 327–8. The chief were the persistent excessive pressure in Burmah, the south and centre of the Bay of Bengal as represented by the Bay Islands, Southern India and Ceylon, and the deficient pressure in Northern and Central India. These peculiarities apparently explain the formation of the storms of the year, in the immediate neighbourhood of the North-West Coast of the Bay, the tendency of the storms to pass into the North-West Provinces, and the absence of storms in Burmah, Arakan, and in North Bombay.

There were eleven storms during the south-west monsoon of 1881. Three crossed the Bengal coast and advanced into Northern Bengal. One crossed the Vizagapatam coast, and marched northwards into Behar. Six advanced across the Orissa coast and passed into the Central Provinces. Two of these marched to the west-north-west across the head of the peninsula into Sind, and four broke up in Central India and the Central Provinces. The remaining storm advanced across the Madras coast in the month of November. The great majority of the storms were formed apparently quite at the head of the Bay, and in this respect differed considerably from those of the two preceding years. The larger peculiarities of the year are described in pages 378–9. They were smaller in amount and less marked than those of 1880. Pressure was slightly in defect in North-Eastern and Eastern India, and very slightly in excess in North-Western, Western and Central India. The absence of large variations is evidently related to the wider and more general distribution of the storms over Northern and North-Western India. The higher pressure in the North-Western Provinces perhaps explains the freedom of that area from the passage of storms into it during the year. Whether there was any peculiarity at the head of the Bay which determined the origin of storms in the immediate neighbourhood of the north coast can only be conjectured in the absence of observations. The observations at the Bengal and Orissa coast stations during the monsoon seem to indicate slightly deficient pressure relative to neighbouring areas.

The conditions antecedent to cyclonic storms may be summed up in the statement that the area to the north of the retreating persistent south-west monsoon winds, during a break in the rains, is one of approximately uniform meteorological conditions. These conditions may obtain to a greater or less extent, and be prolonged for different periods. They are usually terminated by the commencement and continuance of more or less heavy rain and the occurrence of squalls to the south of the area of light and variable winds, that is, over the northern limits of the humid south-west winds of the monsoon circulation. The disturbances, thus initiated, frequently develope into cyclonic storms. The intervals, known as breaks in the rains, are rare in June and July. If an

unusually strong monsoon (considered as a rain-giving current to Northern India) is established, the rainfall is more or less continuous during these months. However strong it may be at its establishment, it necessarily decreases in strength after a short period, and retreats to a slight extent, after which a second advance occurs; and this intermittent action continues during the remainder of the south-west monsoon period. The intervals known as breaks in the rains are, hence, of comparatively rare occurrence in the early south-west monsoon months of June and July. They become a more or less prominent feature of the later months of the south-west monsoon. Their number, or frequency of occurrence, hence depends upon the rapidity with which the bursts of monsoon winds and rain are exhausted, and the conditions are re-established for the advance of the succeeding burst. These conditions are to a certain extent opposed to each other; as one depends, more or less inversely, upon the strength of the monsoon winds in the south of the Bay; and the other directly. The period of maximum storm occurrence during the south-west monsoon is, thus, intermediate between the month when the monsoon is strongest (in June) and when it is weakest (in November).

The following table gives the distribution of the cyclones in each year of the period 1877–81, according to the months in which they were generated:—

Year.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1877	1	...	1	4	1	...	1	...	8
1878	...	...	1	2	2	2	1	1	9
1879	2	...	...	1	2	2	2	...	9
1880	1	1	1	2	2	1	1	...	9
1881	1	3	2	2	1	1	1	...	11
Total	5	4	5	11	8	6	6	1	46

The second series of charts (plates XXVII and XXVIII), which give the distribution and paths of the cyclones for each month of the monsoon period, is very interesting. In these charts, in the cases of storms generated at the end of one month and broken up during the beginning of the next month, the storm tracts are entered for the month to which they chiefly belonged. Hence, in one or two months, the number of storms given in these charts differs slightly from those of the preceding table. An examination of them appears to establish the following general conclusions. Whether the accumulation of further materials, and the consideration of the storms of a period extending over ten or twenty years, will modify these inferences to any considerable extent, will remain to be seen; but the distribution of the storms of the past three years, 1882, 1883, and 1884, appears to conform as a whole to that of those of the preceding few years, and if they had been included would have supported the present conclusions strongly.

1. In the month of May, cyclones are formed occasionally at the first advance of strong south-west monsoon winds into the Bay. There is a tendency for these storms, when generated during the first three weeks of the month, to pass westwards to the Coromandel coast, which they usually cross in the neighbourhood of Madras. If formed during the last week of the month, they are usually generated further north, and pass across the Bengal or Orissa coast.

2. Storms are apparently no more frequent in June than in May. The two branches of the monsoon current are rarely fully established before the end of June. The storm chart for June shows that the storms generated in that month during the years 1877–1881, crossed the Bengal and Orissa coasts. Two advanced into Northern Bengal, and two into the Central Provinces, the latter being comparatively feeble storms. Hence storms are usually not frequent in June. They either pass northwards in Bengal, where they are dependent only on the Bengal branch of the monsoon current, or advance into the Central Provinces, where they give moderate rain. There is, however, apparently little or no tendency for storms in this month to march across the head of the peninsula.

3. The probability of storm occurrence in the month of July, as judged from the number of storms during the period of discussion, is slightly less than in May or June. The chief feature, shown by the storm chart of the month, is the strong tendency of the storms of the month to pass westwards across the head of the peninsula, along the belt of low pressure and interaction intermediate between the two branches of the monsoon current. Five storms belong to this month. Two advanced into North Bombay, and the remaining three into Central India or Rajputana. Hence, the probability of the occurrence of storms in July is practically the same as in May or June; and there is a very strong antecedent probability that a storm generated during this month will pass westwards into Central India, and a moderate probability that it will advance into North Bombay.

4. Cyclonic storms in the years 1877–81 were most frequent in the month of August. All were generated near the head of the Bay. Five out of the eleven storms which originated during this month passed northwards into Bengal or Behar. The remaining storms advanced westwards into Central or Western India. Hence, the experience of five years indicates that storms are most frequent in August, and that the probabilities of their passing northwards or westwards are about equal; and the probability that a storm, which has crossed the Orissa hills, will pass into the northern districts of Bombay or Western Rajputana is about $\frac{1}{3}$. An inspection of the plates shows that their average line of advance across the head of the peninsula is slightly further south than it is in July.

5. September comes next to August in respect to storm frequency. Eight storms were generated and passed landwards in the period 1877–81. Two advanced northwards into Behar, and the remaining six westwards into Central or Western India. The probability of their advancing into North Bombay or Western Rajputana is, hence, greater than in August, and their line of advance is, on the average, slightly further south than it is in August. A comparison of the storm charts of July, August, and September shows, most strikingly, the southward shift of the belt of storm advance across Central India, with the progress of the monsoon season. Hence it appears that storms are somewhat less frequent in September than in August, and that they are all generated near the head of the Bay. There is also a greater probability of a storm, originating in this month, passing westwards across the continent, and to a greater distance than a storm generated in August.

6. The number of storms in October 1877–81 was about the same as in July and May. They were generally formed further south than those of the intermediate period, and in the centre of the Bay. Three of these storms passed northwards into Bengal or Behar, and the remaining three to the coast between Gopalpore and Masulipatam, where they broke up in the immediate neighbourhood of the sea. These facts

indicate the probable character of the October storms. They are usually generated in the centre of the Bay, and pass northwards or westwards to the coast districts, and generally break up near the first line of hills they meet in their course. There is a strong probability of the occurrence of one storm each year in this month.

7. The number of storms in the month of November was six, the same as in October. An inspection of the chart shows that they were all generated in the centre or south of the Bay, and that all were broken up shortly after reaching the coast districts, and on approaching high ground. The only marked difference between the storms of October and November is that the latter are usually generated further south than the former, and frequently in the south of the Bay, off the Coromandel Coast, to the north-east of the East Ceylon Coast.

8. Only one storm was formed in December, and that in the first week of the month. The occurrence of a storm in that month is, therefore, comparatively a rare phenomenon.

A consideration of the previous statements appears, then, to establish the following indications and probabilities of the generation and occurrence of storms in the Bay, during the south-west monsoon:—

1. There is a strong probability of the occurrence of one cyclone each year during the May transition period, or before the complete establishment of the south-west monsoon.

2. The number of cyclones during the early monsoon months of June and July, when the monsoon is established in its greatest force and is steadiest, is small. The probability of a cyclonic storm is small, and is no greater in June and July than in May, and varies inversely with the strength of the Bay of Bengal branch of the monsoon current.

3. Storms are always of frequent occurrence in August and September, the former month being that of most frequent storm occurrence. The probable number of storms in each of these months is two.

4. Storms occur somewhat more frequently in October and November than in May, and there is on the average one in each month in each year.

5. Storms seldom occur after the end of November, and very rarely after the 15th December.

The magnitude and intensity of a cyclonic storm in the Bay of Bengal during the prevalence of the south-west monsoon appear to depend mainly upon the following conditions:—

1. The extent to which approximately uniform conditions are established before the initiation of the disturbance.
2. The strength of the humid southerly winds, and the rate at which the supplies of aqueous vapour are brought up by these winds.
3. The distance from the shores of the Bay of its place of origin.

The preceding discussion has shown that a large proportion of the storms of the south-west monsoon cross the Orissa coast. The majority of these pass over the Orissa hills into the Central Provinces. Of the 46 cyclonic storms, recorded during the period 1877–81, 21 passed over Orissa: 20 of these were generated during the intermediate period or south-west monsoon proper, and 16 out of the 20 passed across the Orissa hills into the Central Provinces. A small proportion of these (4 in number) advanced across the head of the peninsula into the northern districts of the Bombay Presidency, including Gujarat, Cutch, and Sind.

The following are the examples during the five years 1877–81 :—

1877.	No.	II	Storm of	July	10th to 15th.
1878.	„	IX	„ „	„	20th to 30th.
„	„	XII	„ „	September	13th to 20th.
1881.	„	XLIV	„ „	„	11th to

Hence, storms march across the peninsula only during the intermediate period, and when both monsoon currents are fully established, *i.e.*, in July, August, and the early portion of September.

The years 1879-80 present also a number of storms which advanced westwards into the Central Provinces, and either broke up there, or recurved to the north, and marched into the North-West Provinces or North Rajputana.

The explanation of the motion of these storms is by no means simple, and it is very desirable that their phenomena should be more fully investigated. Their motion appears, so far as can be judged from the present imperfect and partial analysis, to depend upon the fact that there is, during the months of July, August, and September, an intermediate belt stretching across India to the south of the Gangetic plain, which separates the area mainly under the influence of the Bay of Bengal current, and in which the winds are approximately steady and from directions between south and east, from the area in which the Bombay branch of the monsoon current prevails almost exclusively, and in which westerly winds are predominant. This intermediate region is characterized by much interaction between the two currents; and the air-motion is, hence, very variable and unsteady. There is also a marked tendency to slight barometric depression, which frequently gives rise to a trough of low pressure, stretching generally from Orissa to the west or north-west, into Rajputana or North Bombay. It is not possible to locate the belt exactly, as it is evident that it will apparently shift from day to day with the local variations of pressure. Its average position will clearly depend upon the relative strengths of the two branches of the monsoon currents, and also upon the general strength and extension of the monsoon circulation. It will hence move northwards or southwards during the transition periods, if it be in existence, and will oscillate to some extent during the intermediate period.

There appears to be a very marked tendency for the storms, which are generated at the head of the Bay during the height of the monsoon and cross the Orissa coast, to advance along this belt of variable winds or trough of low pressure. This supposition, it will be seen, is confirmed to a certain extent by the paths of the cyclonic storms under consideration. In the year 1877, the Bombay current was weak, and the only storm which advanced across the head of the peninsula, marched almost due west into Gujarat, and occurred in July, when both branches are usually strongest. Two such storms occurred in 1878, in which year the Bombay current was unusually strong. The first advanced in July into the northern districts of Sind, and the second in September, when the current was weaker, into Gujarat and Cutch, or along a line further south than in the preceding case. In the years 1879 and 1880 the Bombay current was comparatively weak. The rainfall in the North-Western Provinces and Upper India was very considerably below the average. The Bay of Bengal branch of the current was, thus, also mainly confined to Bengal and Orissa, and the interaction was much smaller than usual; and hence probably extended to a less distance westward than usual. Several storms passed westwards into

the western districts of the Central Provinces, but not one advanced into the Bombay coast districts. Abnormal local conditions determined the advance of one or two of these storms into the western districts of the North-Western Provinces, but that line of march is very unusual, and no example has occurred during the five years 1880–84. In 1881 the conditions were approximately normal. One storm, in September, marched across the head of the peninsula into Gujarat, and was similar in general character to those of 1880, but was feeble and short-lived.

It would thus appear that the cyclonic storms of the months of July to September which advance across the Orissa hills tend to roll along this intermediate area of interaction between the two branches of the monsoon current. What the forces may be which determine the motion in these cases, it would probably be difficult to ascertain. Cyclonic storms, in the Bay of Bengal and in Bengal, always advance in a direction more or less northwards, and are hence apparently carried, or pressed forward, by the advancing mass of humid southerly winds which follow them. In the present class of storms, the strong winds which bring up the aqueous vapour (the condensation of which appears to be necessary to maintain the circulation) to the storm area when it is marching from the Orissa hills across the continent are undoubtedly westerly winds. This is most conclusively proved by various facts fully indicated in the preceding pages. These winds give rainfall almost entirely in the southern half of the storm area. Hence, these storms march in directions opposite to that of the important rain-giving winds, and in this respect differ from those which are carried into Bengal. If it could be assumed that the motion of the rotating mass of air was similar to that of a rolling rigid body, there would probably be little difficulty in explaining its motion to the west along the intermediate area, by the frictional action of the westerly winds to the south, and the easterly winds to the north. Such an assumption is however inadmissible. The simplest hypothesis undoubtedly would be that it marches in the direction of most intense rainfall. There, however, appears to be little or no evidence in favour of this assumption.

It is possible that the belt of interaction may be, before the storms, an area of diminished or least relative air-motion, and that it may thus be the line of least resistance in front of the travelling vortex at the time.

Whether this suggested explanation be the true one or not, the difference between the cyclones which advance northwards into Bengal with rain-giving winds and those which cross the head of the peninsula is remarkable and interesting. The following conclusions appear to be fully established by recent storm experience :—

1st.—Storms generated in the Bay of Bengal may advance through Orissa and the Central Provinces into North Bombay, during the period when both branches of the monsoon current are fully established; that is in July, August, and September.

2nd.—The path, or line of advance appears to depend, partly upon the extension of the monsoon circulation, and partly upon the relative strength of the two currents, and, for a considerable portion of its course, is approximately coincident with the narrow elongated area of interaction of the two currents.

The preceding discussion has disclosed several points of difference between the cyclonic disturbances of the intermediate period, when south-west monsoon conditions are established over the whole Indian area, and those of the transition periods, when the south-

west monsoon circulation is expanding or contracting, and its northern limits advancing or retreating over the Bay. A massive atmospheric circulation, such as the south-west monsoon or the South-East Trades, consists of a lower and an upper air current, the directions of which are opposed to each other, and of an ascending and a descending air current. The complete motion forms the whole circulation, and in order to maintain the motion against the various resistances, there must be either a more or less continuous conversion of energy in the current from the potential to the kinetic form, or an addition of energy derived from external sources.

It is probably of little importance at which part of the circulation the addition or change of energy occurs.

The south-west monsoon circulation appears to be the northward extension of the South-East Trades and to form a part of that general circulation. This extension is, in the first place, due to atmospheric actions dependent upon the rapid accumulation of heat and increase of temperature in Southern Asia during the months of April and May. The South-East Trades are usually continued across the equator during the first or second week of May, and advance northwards in one or more bursts, after which they are established over the Bay and extend into the interior, and effect that change in the weather marked by the transition from intensely dry hot weather to the rainy season, when a moderately high temperature, a very humid atmosphere, much cloud, and frequent rain showers, obtain over the greater part or the whole of India. Hence, during the south-west monsoon, the ascending motion, which forms an integral portion of the circulation, occurs chiefly over India, so that Northern India forms the northern limit of the complete atmospheric circulation constituting the South-East Trades and the south-west monsoon. The changes in this circulation are always more or less discontinuous, partly in consequence of the viscosity of the air, and partly the effect of actions accompanying rainfall, which is the most important discontinuous atmospheric action.

The northward extension of the South-East Trade winds across the equator and their continuation up the Bay is a meteorological phenomenon of a different order of magnitude and intensity from that of the establishment and gradual intensification of the local sea-winds at the head of the Bay and on the Bengal Coast, in February and the hot weather months. The latter is sometimes spoken of as the commencement of the south-west monsoon, but it seems to me desirable to restrict the use of the term south-west monsoon to the former meteorological period, and I have done so throughout the present paper.

There are various reasons in favour of the assumption that during the intermediate period of the rains in the Bay, the air-motion of the south-west monsoon circulation extends to a much greater elevation than it does during the transition periods. They are in part given in the Report on the cyclonic storm of October 1882 in the Bay of Bengal (Meteorological Memoirs, Vol. II, Part III).

Many phenomena of the cyclonic storms of the Bay appear to be explicable, only on the assumption that the aqueous vapour condensation, and hence the addition of energy to the circulation, occur at a much greater height during the rains proper than during the transition periods. This I have expressed in a previous paper, by dividing cyclones in the Bay into two classes—one of low elevation and the other of high elevation.

The cyclones of the transition periods are formed near the northern edge of an advancing or retreating south-west monsoon circulation, and consequently where it tends to thin off. Hence, the whole motion, consisting of the vertical and horizontal currents, is probably confined within the lower atmospheric strata.

On the other hand, during the rains proper, when south-west monsoon conditions are generally established and rain is falling, either locally or generally, over the greater part of India, and at very considerable elevations on the Himalayas, it is almost certain that the complete air-motion of the south-west monsoon circulation extends to a very considerable height over the Bay and Indian areas, and that the air-motion near the earth's surface is probably a very unimportant part of it and gives very feeble indications of the strength and extent of the circulation in the higher atmospheric strata.

Hence, the storms of the transition periods are cyclones of low elevation. The air-motion at and near the earth's surface is always more or less violent. They form frequently in the centre of the Bay, and in that case march to the land by a longer path than those of the rains proper. The strength, or intensity of a cyclonic storm depends in part upon the length of time during which it is passing over a sea area, which is much more favourable to the accumulation of motion than its passage over land, where the resistances are much greater; more especially in the case of cyclones of low elevation. Hence intensity and magnitude of storms of the transition periods vary within much wider limits than the storms of the intermediate period. They advance into the plain districts of Burmah, Bengal, or the Madras Presidency, and rarely, if ever, pass over hills of an elevation exceeding 2,000 or 3,000 feet. The most intense cyclones of recent years, *viz.*, the Calcutta cyclone of October 1864 and the Backergunge cyclone of October 1876, were broken up within a very short period after reaching land.

The cyclones of the intermediate period are generally cyclones of high elevation. The barometric depression is always small and rarely exceeds four-tenths of an inch. The air-motion in the lowest atmospheric strata is seldom violent, and is occasionally less than the normal air-motion of the period. It is also generally more or less irregular, and, as might be expected, to a much greater extent on land than at sea. Judging by the magnitude of the barometric depression and the intensity of the winds as standards, they are feeble storms. They are, however, remarkably persistent on land, their existence depending apparently on the available supplies of aqueous vapour. When both branches of the monsoon current contribute to feed a storm, it may continue in undiminished strength on land for four or five days, as in the case of those which cross the head of the peninsula to the Bombay Coast districts. They surmount, with little apparent change, such obstacles as the Orissa hills and the broken ground of the Central Provinces and Central India. The rainfall that accompanies them is generally much more diffused and less concentrated than that which is associated with the cyclones of the transition periods. The strong southerly humid winds, which follow in their rear, usually spread over the interior, and give much rain after the disturbance has passed away or has broken up.

One remarkable feature in Indian meteorology is the occurrence of groups of storms, formed in rapid succession, apparently under the same conditions, following the same track, and having the appearance of being the repetition of similar meteorological phenomena and actions. A storm is an abnormal feature, due to abnormal actions, and tends to obliterate the abnormal features which give rise to it. It may, however, happen that the

peculiar meteorological conditions which determine the path of a cyclone along a particular line may be so strongly developed as to be still present, to a marked extent, after its disappearance; and hence, that another storm, formed shortly afterwards, during the same south-west monsoon and under similar conditions in the Bay, will follow along the same track.

Amongst the more remarkable examples of the period under discussion are the following:—

(1) A series of four storms which advanced westwards from the Bay across the Vizagapatam coast during the months of October, November, and December 1878.

(2) A series of four storms which formed in the immediate neighbourhood of the Arakan coast near Akyab in September and October, 1879, and passed to the north and west.

The following tables give the chief features of the pressure distribution and air-motion at the coast stations of the Bay of Bengal, between July and December 1878:—

Pressure.

Station.	July.	August.	September.	October.	November.	December.
Port Blair	+·015	+·031	—·015	—·017	—·057	—·043
Akyab	+·055	+·049	—·037	—·047	—·072	—·080
Chittagong	+·087	+·073	—·014	—·043	—·066	—·071
Saugor Island	+·070	+·049	—·014	—·047	—·076	—·067
False Point	+·026	+·007	—·040	—·057	—·092	—·075
Vizagapatam	+·028	+·010	—·031	—·052	—·095	—·096
Madras	—·034	—·032	—·047	—·054	—·060	—·064
Negapatam	—·007	—·021	—·037	—·060	—·066	—·068

Air motion (miles per day.)

Station.	July.	August.	September.	October.	November.	December.
Port Blair	190	212	259	191	174	209
Akyab	86	75	72	48	44	46
Chittagong	153	139	65	63	78	65
Saugor Island	318	291	211	141	139	163
False Point	192	181	121	116	146	167
Cuttack	85	72	43	49	64	58
Vizagapatam	67	56	30	28	32	40
Madras	155	150	153	130	150	184
Negapatam	107	105	91	72	66	91

Percentage of the actual to the average amount of wind daily.

Station.	July.	August.	September.	October.	November.	December.
Port Blair	70	87	102	115	101	137
Akyab	100	97	100	87	80	82
Chittagong	85	93	57	77	87	67
Saugor Island	103	114	93	104	112	111
False Point	79	83	68	85	99	105
Cuttack	91	97	67	94	156	157
Vizagapatam	64	69	53	57	53	72
Madras	65	74	82	87	79	86
Negapatam	63	78	82	101	65	66

Steadiness expressed as a percentage.

Station.	July.	August.	September.	October.	November.	December.
Port Blair	61	62	72	60	28	79
Akyab	69	60	39	12	31	41
Chittagong	54	62	28	18	43	43
Saugor Island	72	68	40	7	54	88
Cuttack	57	55	17	13	51	71
False Point	66	53	39	26	53	52
Vizagapatam	66	66	43	7	46	48
Madras	72	80	62	9	47	71
Negapatam	86	90	86	77	78	62

The preceding tables illustrate the local features in the distribution of pressure, and of the air-motion before and during the period when the Vizagapatam coast was visited by four storms in 1878 in rapid succession. They show—

1st.—That pressure was relatively lowest at Vizagapatam during the months of November and December, but not during the preceding months. The greatest deficiency of pressure in July, August and September was shown by Madras. The low pressure at Vizagapatam during the months of October to December was, in part undoubtedly, an effect of the passage of the storms across the coast. Hence the chief antecedent determining condition and indication is not apparently to be sought in this direction. And this might have been anticipated, as the pressure at any point of the atmosphere is the integrated effect of the whole air-motion horizontally and vertically, not only at the

place considered, but in all neighbouring regions connected with it meteorologically so far as to produce an appreciable effect. The same resultant pressure may, it is evident, arise from very different conditions of air-motion.

2nd.—The air-motion at Vizagapatam was, before and during the storm months or during the whole monsoon period, unusually and remarkably feeble, not only relatively to the normal motion, but absolutely. This is very fully shown by the two tables of average daily amount of wind for each month, and the percentage of the average amount to the normal average amount. This peculiar feature was, it should be noticed, quite as strongly presented during the months of October to November as previously, although the passage of the cyclonic vortices gave a large amount of wind, and tended to raise the average wind amount considerably above its general or average value, *i.e.*, the value during the intervals of no disturbance. The last table seems also to show that winds were very unsteady. This feature was, however, no more strongly marked than at several other stations.

Hence the meteorological observations at Vizagapatam present one, and only one, strongly marked abnormal feature before and during the storm period of 1878, *viz.*, unusually feeble air-motion, considered either with respect to that at neighbouring stations, or relatively to its normal amount. In previous cyclone reports I have pointed out the tendency of cyclonic disturbances generated in the Bay to advance along the line of least relative air-motion, and the present appears to give additional confirmation to the induction that it is one (if not the chief) powerful determining condition.

The history of the storms of the year 1879 show that there was a very strongly marked tendency to the origin of cyclonic disturbances in the immediate neighbourhood of the Arakan coast. This was most strikingly shown in the months of September and October. The following tables give data for the monsoon months, July to November 1879, similar to those of the preceding year given above :—

Pressure.

Station.	July.	August.	September.	October.	November.
Port Blair	—·007	+·001	—·029	—·003	—·050
Akyab	—·002	—·014	—·074	—·054	—·067
Chittagong	+·016	+·006	—·035	—·015	—·022
Saugor Island	+·035	—·009	—·032	—·011	—·003
False Point	+·029	—·036	—·052	—·023	—·014
Vizagapatam	+·023	—·026	—·039	—·014	—·012
Madras	—·015	—·009	—·018	—·012	—·026
Negapatam	+·010	—·004	—002	—·000	—·005

Air-motion (miles per day).

Station.	July.	August.	September.	October.	November.
Port Blair	230	218	276	152	156
Akyab	70	66	45	38	29
Chittagong	133	142	86	61	53
Saugor Island	330	287	217	162	168
False Point	263	232	201	159	157
Vizagapatam	67	80	39	56	70
Madras	170	168	163	123	186
Negapatam	170	174	164	119	162

Percentage of actual to average amount of wind daily.

Station.	July.	August.	September.	October.	November.
Port Blair	88	91	107	93	92
Akyab	83	88	65	72	42
Chittagong	76	95	77	76	61
Saugor Island	106	110	97	117	129
False Point	109	106	113	116	114
Cuttack	72	83	87	78	100
Vizagapatam	68	100	71	112	115
Madras	74	85	89	84	99
Negapatam	100	123	134	137	142

Steadiness percentage of mean direction.

Station.	July.	August.	September.	October.	November.
Port Blair	80	91	82	23	52
Akyab	57	71	56	14	39
Chittagong	55	64	29	24	71
Saugor Island	76	64	28	28	79
False Point	70	55	20	36	80
Cuttack	62	66	37	32	87
Vizagapatam	72	75	66	7	56
Madras	61	89	56	19	55
Negapatam	85	90	91	52	27

An examination of these tables establishes the same facts as in the preceding case. It is not necessary to state the inferences fully. They show—

1st.—That pressure was not very deficient on the Arakan coast until the month of September, when the tendency to storm formation became most strongly

marked. Hence, the deficiency in pressure was partly a result and effect of the storm generation in the neighbourhood, and not a strongly marked antecedent condition.

2nd.—The air-motion during the whole monsoon period was very feeble, when contrasted with that at all other stations in the coast, or with the average motion. The feature was almost as strongly developed as in the preceding case, and extended to the steadiness of the wind which the fourth table indicates was also least on the whole at Akyab.

These two examples show a very strong connection between the abnormal features of air-motion and the origin and motion of cyclonic disturbances in the Bay. The relation, apparently, being that storms in the Bay of Bengal tend to originate in areas of feeble air-motion (and perhaps deficient pressure), and to move in the direction of least relative air-motion.

The discussion has shown that, although whirls or atmospheric eddies on the large scale are a common and frequent feature of the south-west monsoon in the Bay of Bengal, the intensity of the storm, as measured by the depression, is usually very small. Storms, in which the depression exceeds half an inch, are of comparatively rare occurrence, and are apparently confined to the transition periods. Of the 28 storms of the monsoon period proper, discussed in this memoir, not one had a depression exceeding a third of an inch, so far as can be judged from the various observations. Continued experience indicates that a storm in which the depression exceeds half an inch is a very rare phenomenon during the months June to September. In the great majority of cases, the depression varies from one to three tenths. It usually diminishes as the storm passes over the coast districts of Bengal and Orissa. In the case of the storms which march into the Central Provinces, the barometric depression occasionally increases as the storm moves westwards. When this is the case, the preceding history has shown that the rainfall also augments and is excessive in the latter portion of its course in the Central Provinces, Central India, Rajputana, and Bombay.

The preceding history has included several cases of two whirls formed during the same general disturbance. In such cases, as might be expected on the supposition that the humid winds supply the motive power and energy which continue the rotatory motion, the first whirl was feeble, and gave comparatively little rain, while the second was more intense, accompanied by stronger winds, and brought up the main body of humid winds to the coast districts. The second whirl in such cases alone gave general and heavy rainfall. The following are the most important examples during the years 1877–81:—No. III, storm of August 6th to 10th, 1877; Nos. XXXVII and XXXVIII, storms of June 5th to 9th, 1880. Also No. IX (storm of July 20th to 30th, 1878) and No. XXXIII (storm of September 21st to 28th, 1880) are less striking examples.

It is probable that this is a commoner feature of disturbances generated at the head of the Bay than is apparent from the discussion, as several of the smaller whirls which occurred during the period under discussions, but are not included in it, immediately preceded larger whirls.

Another feature, somewhat similar in its general character, may be also noticed. There are two or three examples amongst the storms under discussion of disturbances

which crossed the Orissa hills and were continued westwards in the Central Provinces, in which the evidence is almost conclusive that one vortex, as indicated by the wind directions, was broken up during or shortly after its transit across the Orissa hills, and another one was formed some distance to the west. The most striking example was storm No. XXX, lasting from the 31st July to the 9th August 1880; (pages 313–50).

The importance of rainfall as a factor in determining the initiation, growth, and motion of cyclonic vortices has been already stated. The relations between the distribution of rainfall and the more important phenomena is of great importance, but it is not possible to discuss it fully, except for a single storm. There are, however, several features and facts connected with the distribution of rainfall during cyclones, which it is advisable to state briefly.

The history of the 46 cyclones included in the present report has shown fully that they were all accompanied by heavy rainfall, and that they all brought up more or less humid winds, for considerable periods, to the districts in the rear of the cyclone; so that each cyclonic disturbance preceded a burst of monsoon rains over a portion of the Empire. Hence their occurrence is of considerable importance in connection with the distribution of rainfall during the south-west monsoon in India. The history has also roughly shown that the severest cyclones, (as, for example the Vizagapatam cyclone of November 1878 and the Negapatam cyclone of November 1880, in each of which the depression exceeded half an inch,) were associated with the most concentrated and localized rainfall. The same fact is also indicated more or less clearly by the history of the storms. There is always heavy localized rainfall over the area of cyclonic disturbance, and the strength and character of the disturbance depend, to a very large extent, upon the amount and character and distribution of the rainfall. This has been pointed out in previous cyclone reports and need not be discussed here.

The rainfall that occurs during cyclonic disturbances in India is frequently excessive. The heaviest falls occur in the plain districts of Northern India, where the almost absolute uniformity of level of the surface is apparently opposed to such excessive local precipitation. The following known examples of falls of rain, exceeding 30 inches in the 24 hours, occurred during south-west monsoon cyclonic storms in the period 1877–81 :—

Station.	Date.	Amount.
Purneah	13th Sept. 1879	35·34
Nagina	18th Sept. 1880	32·49
Dhampore . . .	ditto	30·40

Another important fact is that the rainfall is very irregularly distributed over the cyclonic area. In Bengal and the adjacent districts, the largest amounts appear to fall in the southern and eastern quadrants, in which the rain is brought up by southerly winds, while, in the peninsula and Western India, the rainfall is excessive only in the south-western and south-eastern quadrants, and comparatively light in the northern half of the depression. The general distribution of the rainfall is, as a rule, strictly related to the branch of the monsoon current which feeds it.

The daily charts also show that, in the majority of cases, there is a large amount of irregularity in the winds, during the passage of a cyclonic disturbance across the Orissa hills. This is only what might have been expected. The air-motion is comparatively feeble in the lower atmospheric strata in such cyclones. The first lines

of the Orissa hills are at a distance of about 50 miles from the sea, and rise in their central ranges to elevations of 3,000 to 4,000 feet. They form a mountain mass of considerable width. They are interposed directly in front of the path of the storms. It is evident that the obstacles and resistance which this broken ground presents to the rotatory motion will be very great, and tend to make it very irregular, and to disintegrate the whirl in the lower atmospheric strata. Even if the vortex crosses the broken ground, the air-motion in the lower strata would undoubtedly be very irregular after such a march. The hills will also, after the passage of the whirl, obstruct the flux of vapour from the Bay of Bengal, and the continuance of the vortex will hence depend mainly upon whether it receives adequate supplies of vapour from the Bombay current. It is evidently probable that the general disturbance in the Orissa hills might be propagated westwards and give rise to cyclonic rainfall and the formation of a new vortex in front, in the Central Provinces, by various actions which it is not necessary to enumerate, and this, it has been pointed out, occasionally occurs.

It is well known that any prolonged disturbance of a particular kind in either water or air sets up rotatory motion, and that the intensity and extent of the vorticose or cyclonic motion increases rapidly with the amount and duration of the disturbance. It is also equally well known that such a motion can be easily broken up by interposing obstacles to the motion in a suitable manner. Any obstacle which produces irregularity in the rotatory motion is effective. A few branches of a tree in a part of a canal, where there is a tendency to such a motion, are, for example, found to be quite sufficient to prevent the motion, and the scouring away of the sides and bottom of the canal, which would otherwise result. Similarly, in cyclonic motion of the air, any obstruction which prevents the regular vorticose flow of the air will tend to disintegrate the cyclonic motion or disturbance; and if the obstruction be large enough, it will, if it acts continuously for a short time, completely break up or destroy the cyclonic motion. There are no such obstructions at sea; but on land, the broken, elevated, and irregular masses which constitute a chain or line of hills evidently form a most effective obstruction. In the case of cyclones in the Bay of Bengal, the motion or disturbance consists of two parts. One-half of the cyclone, including the southern and eastern quadrants, forms what may be called the influential, active, or energetic portion. It is in these quadrants in the open sea that the winds are strongest. It is also the winds blowing in these quadrants, mainly from directions between south-west and south-east, which bring up the aqueous vapour, the condensation of which furnishes the energy that maintains the cyclonic circulation. On the other hand, the winds in the northern and western quadrants are produced by the cyclonic circulation, but do not contribute energy to any considerable extent to continue the motion. Hence, the action in this half of the cyclonic disturbance is comparatively uninfluential and powerless, so far as the continuance of the cyclonic disturbance is concerned.

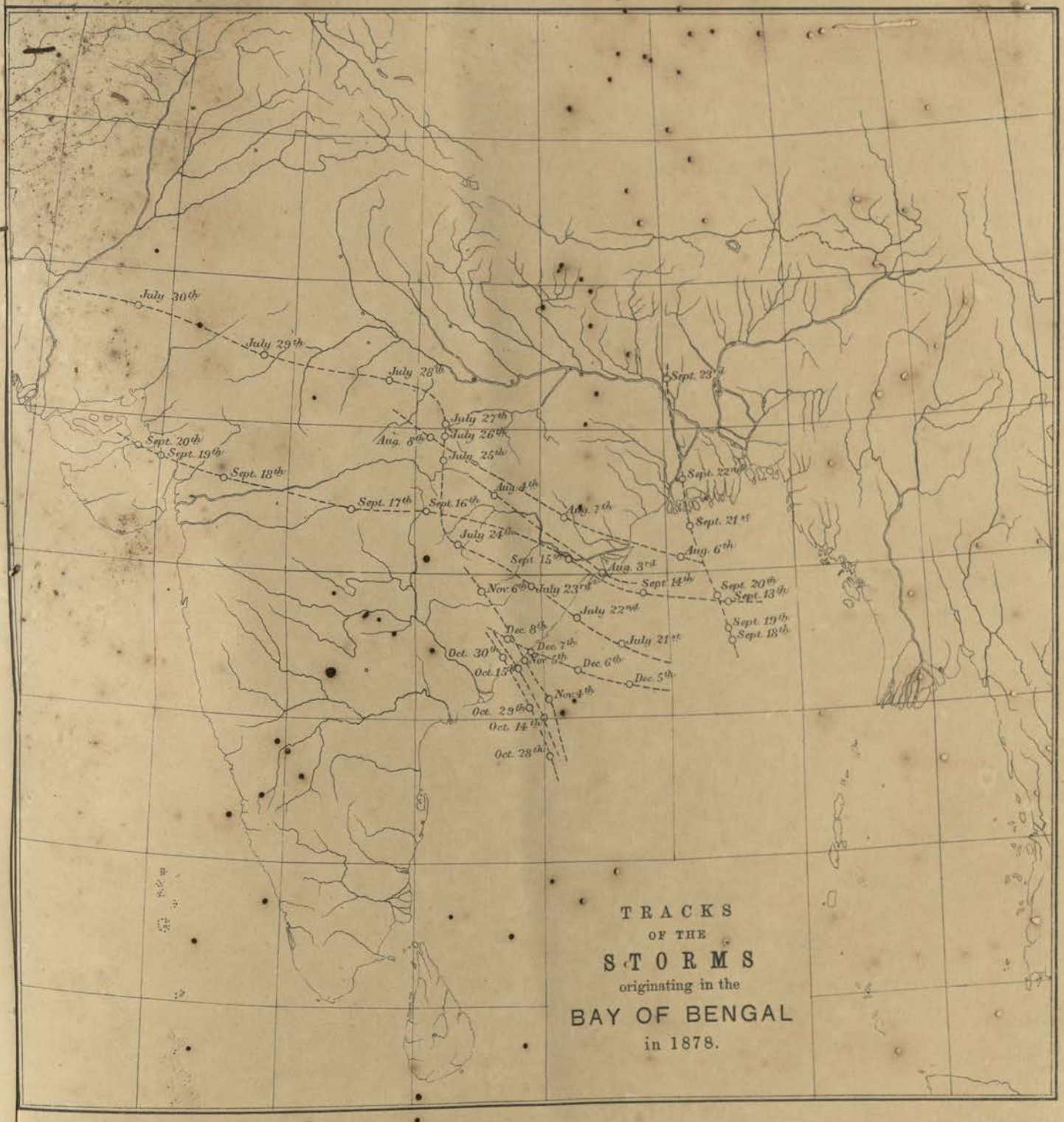
These considerations indicate that the obstruction will be effective if it is interposed in the energetic or influential part of the cyclone. It will not merely tend to break up the cyclonic motion, but also prevent the central area being fed by the moist southerly currents, and hence remove the motive power necessary to maintain the cyclonic disturbance and prevent the introduction of further energy. In other words, if a cyclonic disturbance, in its motion up the Bay, approaches the east coast, which is protected by the Burmah and Arakan hills (attaining elevations of 5,000 to 7,000 feet

in their highest points), they will form a most effective and powerful obstruction to the circulation and to the supply of energy, and the disturbance will, almost certainly, break up, as it approaches and crosses that coast. To assert that a cyclonic storm is approaching the Akyab or Chittagong coast is hence practically the same as stating that it is commencing to break up, and that it will disappear in the course of a few hours. The circumstances are quite different when a cyclone advances towards the west coast of the Bay. The hills are much lower, and hence it appears probable that they will cause a less destructive action than the Arakan hills. Also, as their obstruction occurs in the uninfluential quadrant of the cyclone, it will produce a comparatively trifling result, such, for example, as deflecting it into another direction. Hence such a cyclone will almost certainly either pass across the hills, or else roll along the base of the hills, the cyclonic circulation being maintained intact by the constant addition of energy in the eastern quadrant by the southerly winds. A certain amount of irregular action and motion will, undoubtedly, occur at and near the base of the hills. This, however, produces no large effect in reducing the cyclonic circulation, unless the cyclone be very small and the motive power weak. Numerous examples might be given from the storms of the years 1877–81 in confirmation of the preceding inferences. It appears to be unnecessary to do so. Unless it were possible to classify the storms, it appears to be useless to give average data of the rate of the motion of depressions across the Indian area. In a large number of cases the average daily rates of motion have been given. The rate of motion varies within very wide limits in the case of the storms of the intermediate period. In the Bay itself, it is seldom that a vortex moves with a velocity exceeding 15 miles per hour; and from 10 to 12 miles appears to be the average rate, in the case of storms generated in the south or centre of the Bay. In the case of depressions passing over the land, the rate of motion is more dependent on local conditions than at sea. During the intermediate period, when the disturbances are mainly dependent upon the propagation in the upper regions, the average motion should apparently be approximately uniform. There appears to be a fairly uniform rate of motion in the case of the majority of the storms which advance across the peninsula, but the examples included in the present report are probably too small in number to permit this generalization, and still less to estimate the average rate.

It may be mentioned that an examination of the daily charts show that land-formed depressions, which present in a lesser degree all the features of cyclonic storms, are by no means uncommon during the rains in Northern India. These depressions (judging from the whole of the observations) originate over the land most frequently in Bengal. They are usually developed during the occurrence of heavy rainfall of a more or less localized and concentrated character, and when formed, are more or less persistent and move along a definite path for some time, and then fill up and disappear. For example, four such depressions were formed in Bengal during the months of July and August 1878. One of these drifted westwards from Eastern Bengal into the North-Western Provinces. The wind directions in Northern India showed that this cyclonic circulation continued for eight days, from the 21st to 28th July. Several depressions of this kind are formed during each monsoon in Bengal. They are only generated when monsoon winds are blowing in strength at the head of the Bay, and are bringing up much cloud and vapour.

Government of India Central Printing Office. No. 52 Meteo.—24-5-85.—400.

Lith. engraved at the Survey of India Offices, Calcutta, May 1888.



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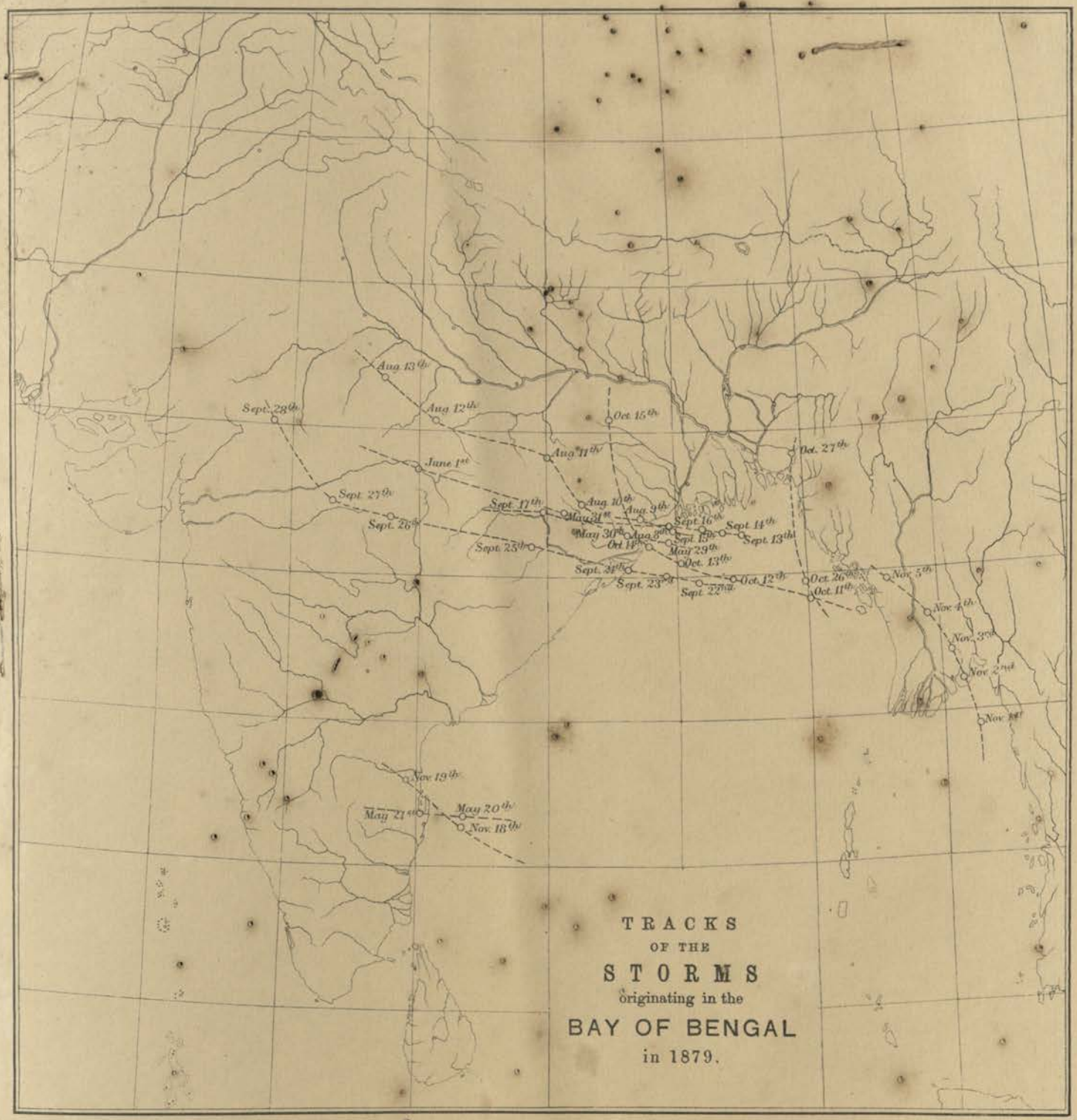

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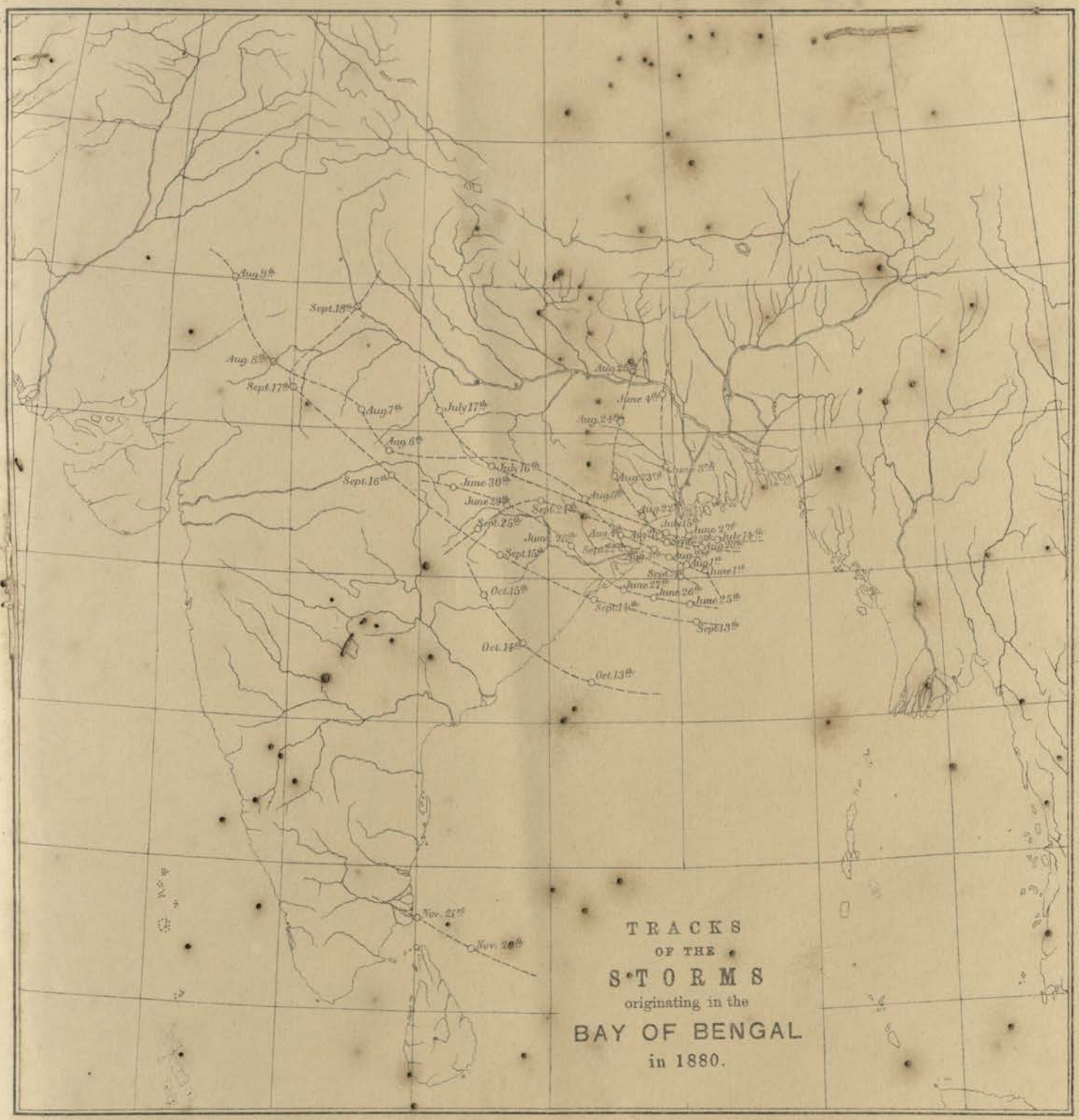

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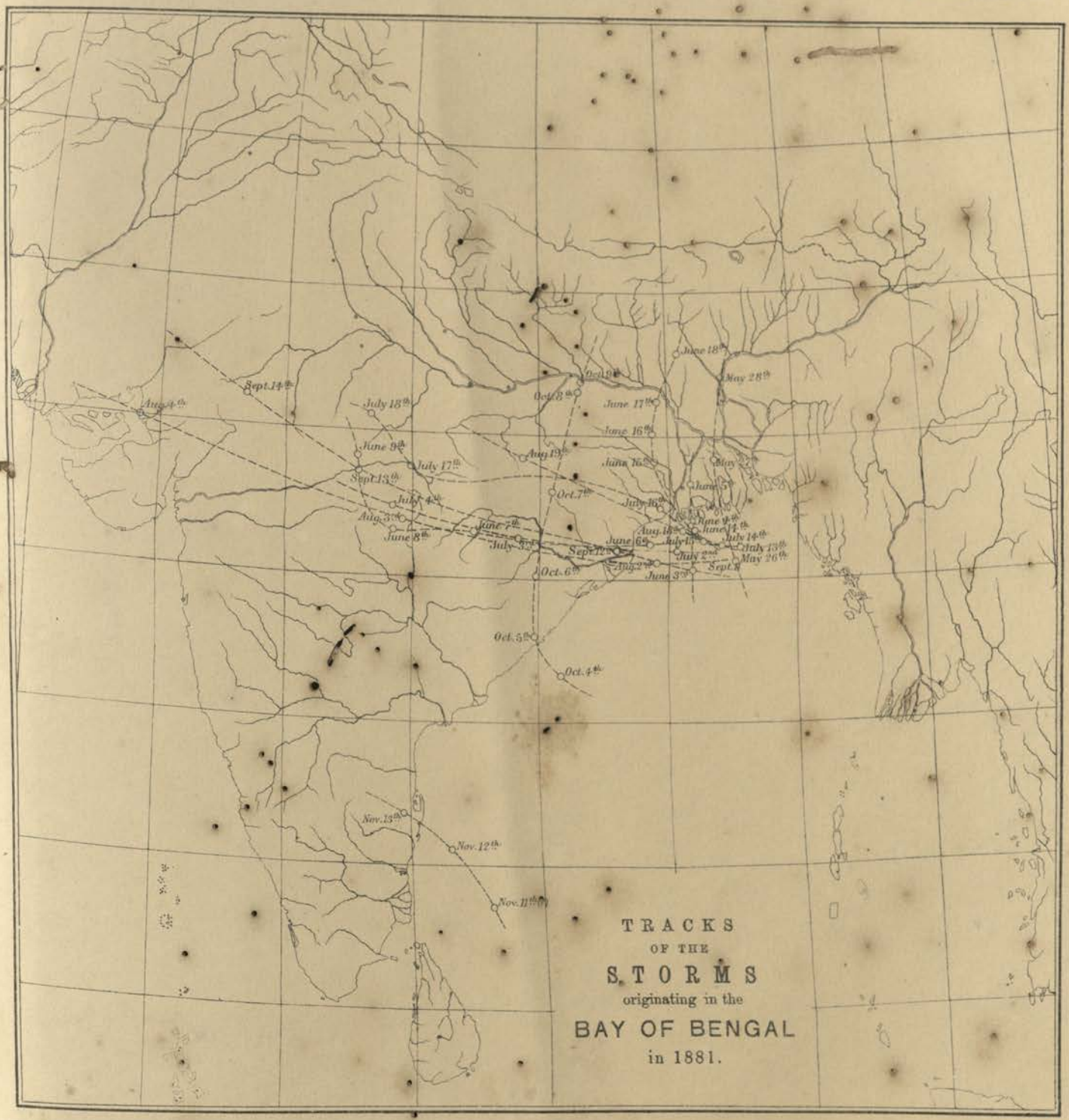

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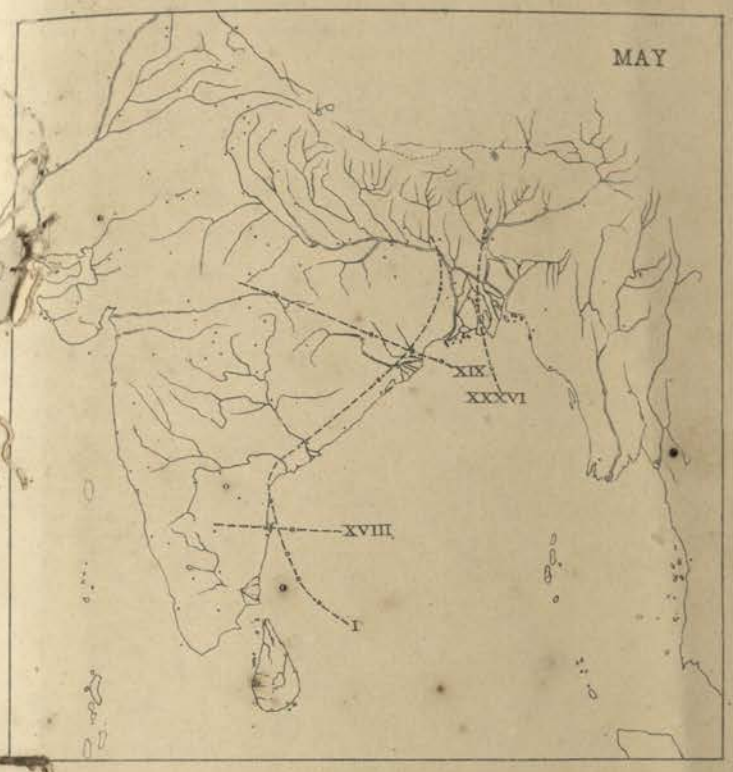
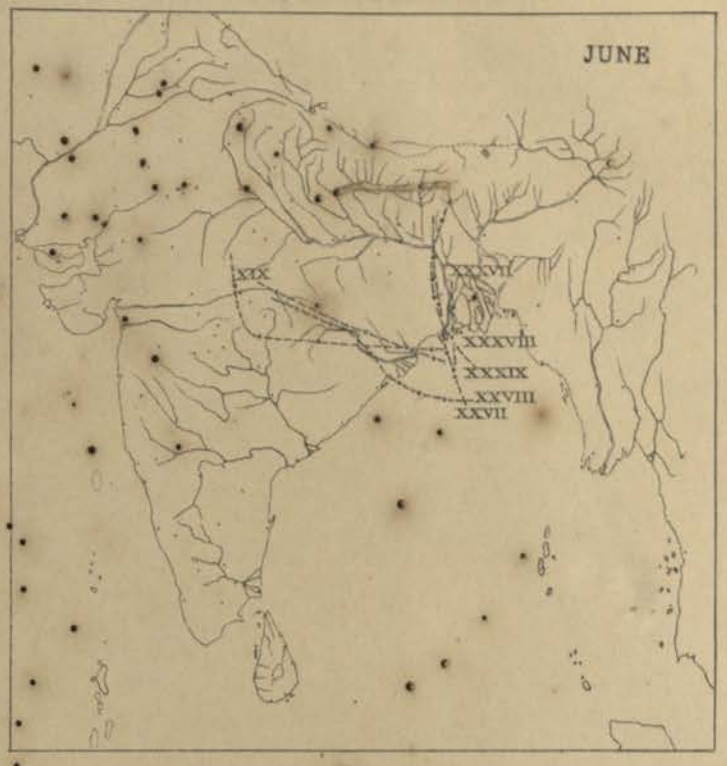
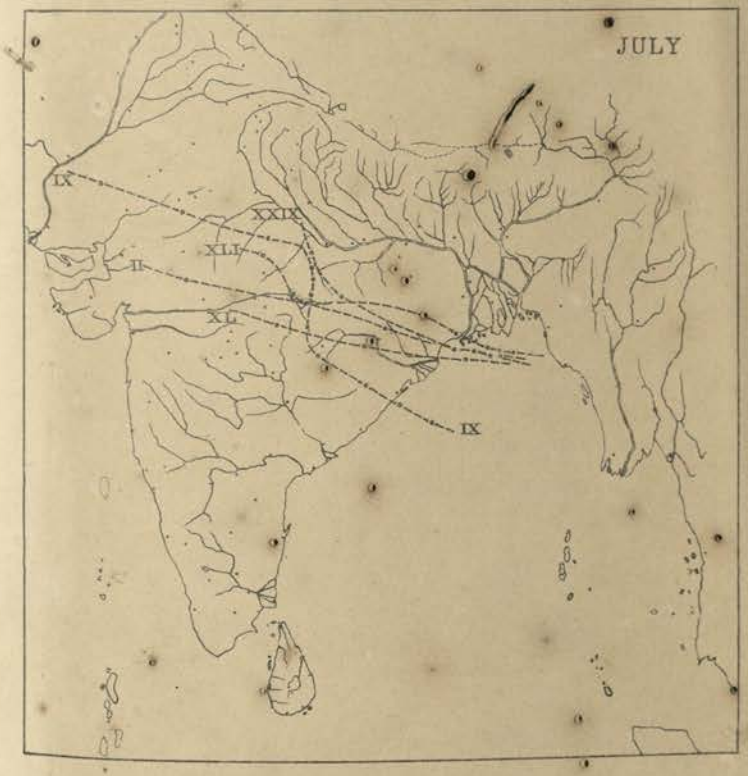
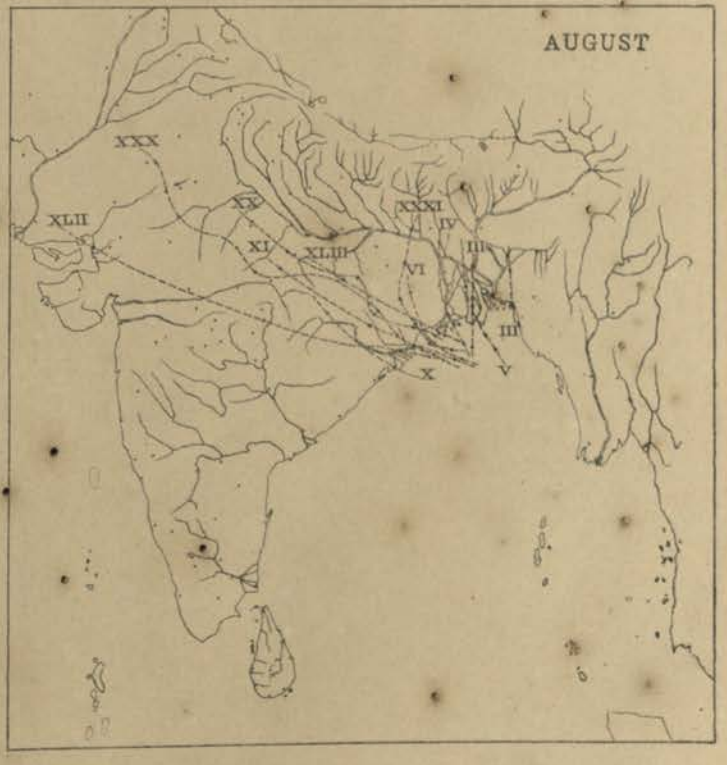


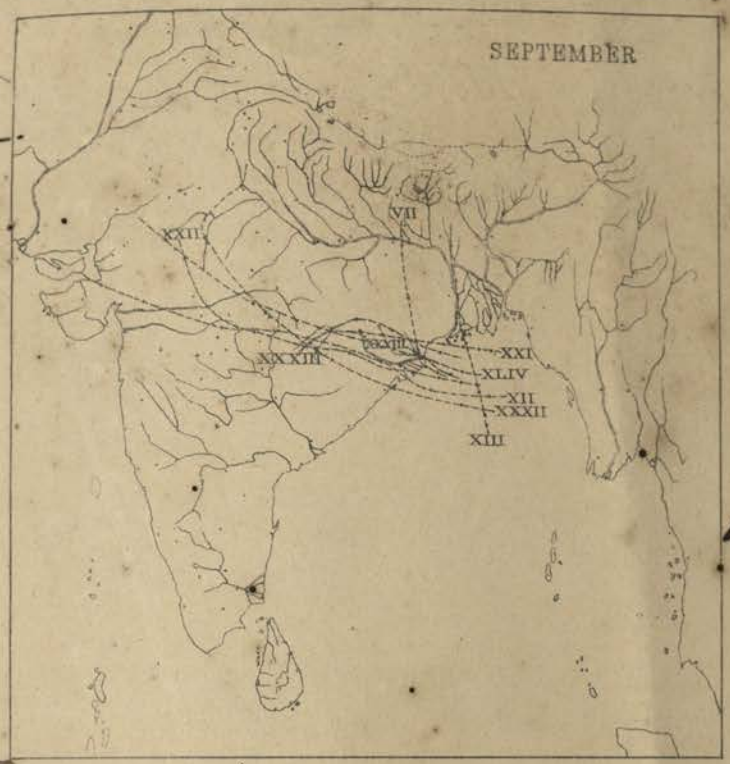


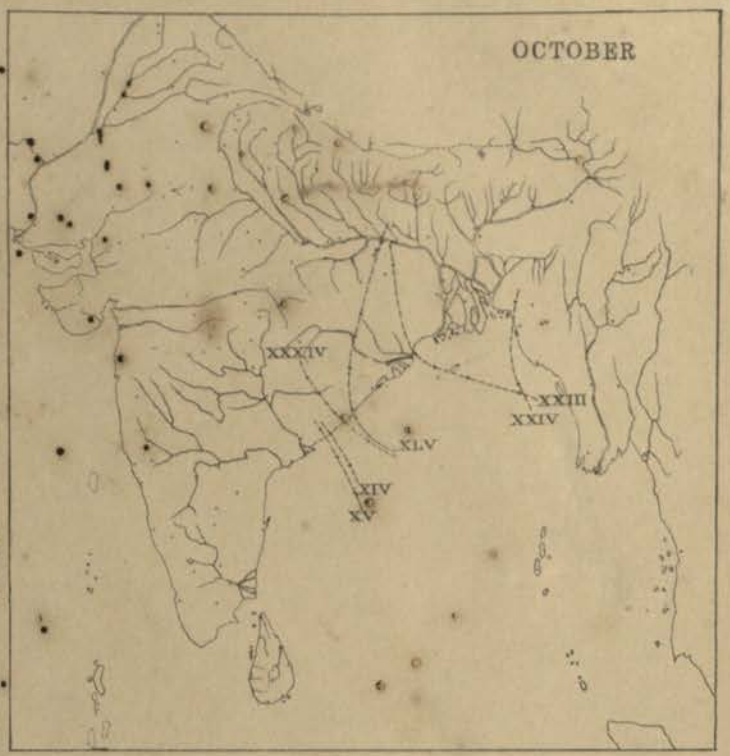


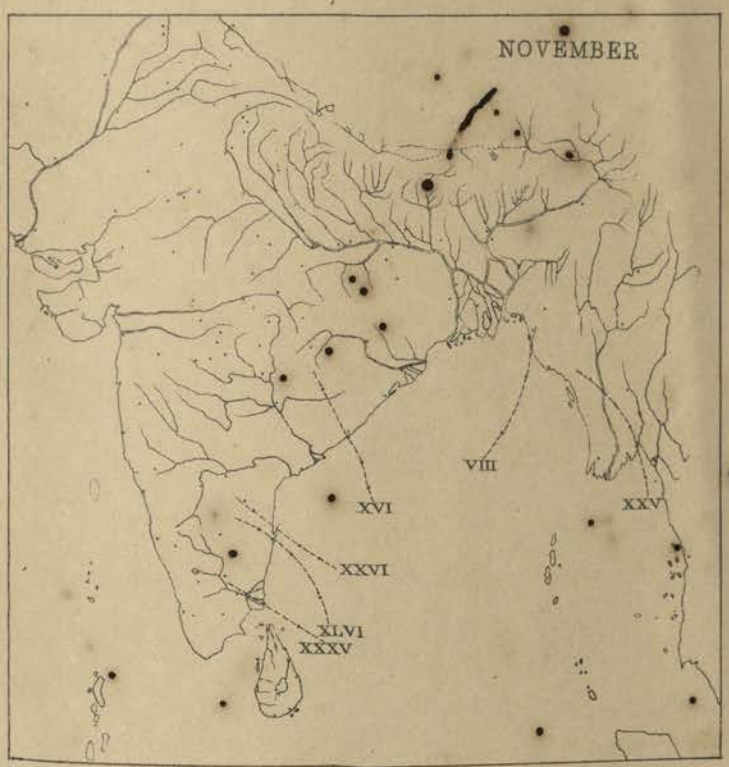


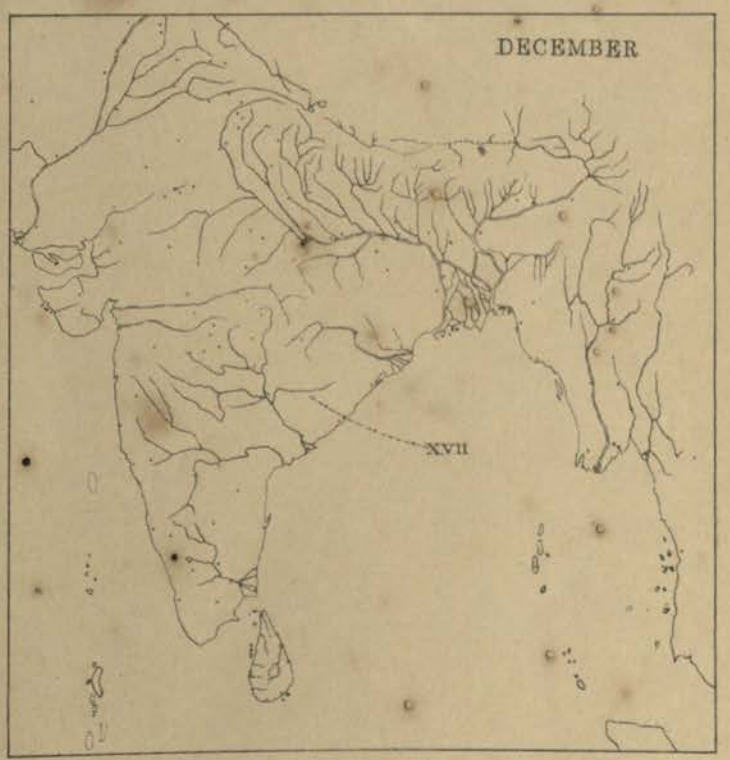
MONTHLY CHARTS OF STORM TRACKS, 1877—81.

Lithographed at the Survey of India Offices, Calcutta, May 1886.









MONTHLY CHARTS OF STORM TRACKS, 1877—81.

Lithographed at the Survey of India Offices, Calcutta, May 1883.

VII.—On Observations of Temperature and Humidity at a height of 40 feet above the ground at Alipore Observatory, Calcutta.—By S. A. Hill, *Metecrological Reporter to Government, North-Western Provinces and Oudh.*

Shortly after the opening of the new Calcutta observatory at the southern suburb of Alipore, an attempt was made to determine the variations of temperature and humidity in the air within a moderately large distance of the ground. A Tál palm tree (*Borassus flabelliformis*) in front of the observatory building having been selected, the crown was cut off so as to leave a stump 40 feet high, which, after being covered with an iron cap to prevent the rain from rotting the wood, and being firmly fixed with stay-ropes of wire, was used to support a thermometer cage, to which access was given by a long ladder.

In Indian observatories the thermometers are usually exposed in cages 2 feet wide, 1 foot 9 inches high, and 4 inches deep, the back and front or door of the cage being of wire netting, while the top, bottom, and sides are of wood. At the top and towards the front, which faces north, there is a projecting roof or pent-house 6 inches wide, and a similar sloping-board, twice as broad, projects at the back. Such cages are always hung under thatched sheds which keep off the direct rays of the sun, the sloping roof of the cage being intended merely to stop the solar rays which may sometimes enter the shed below the eaves when the sun is near the horizon.[1] One of these regulation cages was used for the thermometers at the top of the palm-tree stump; but as in such a position it was impossible to erect a thatched shed over it, the necessary precautions against radiation were made by covering the top and back (or southern side) of the cage with sheets of bright tin plate. Over the top, an air space was left between the tin and the wooden roof of the cage, and at the back two sheets of tin with an air space between were used. As an additional precaution against the afternoon sun, a sheet of tin, which projected to some distance beyond the front of the cage, was attached to its western side.

The exposure was thus similar in all essentials to that given by Glaisher's stand adopted at Greenwich observatory, except that additional protection was afforded by the outer casing of tin plate, in part doubled.

The standard observations of air temperature at Alipore being made under a shed, and there being no certainty that the tin plates, though renewed whenever they grew rusty, would as effectually protect from radiation the instruments on the palm tree, a second cage was fitted up exactly like the first, and exposed near the foot of the tree, at a height of 4 feet above the ground surface.

The instruments in each cage were the following:—

A dry-bulb thermometer.
A wet-bulb do.
A maximum do.
A minimum do.
A minimum wet-bulb thermometer.

All these were verified by comparison with a Kew standard, and their errors have been duly corrected.

The observations commenced in April 1878, and were continued for a period of four years,—that is, to the end of March 1882. The primary corrections and reductions were

[1] Figures of the cage and shed drawn to scale are given on Plate I, Part I, of the *Indian Meteorologists' Vade-Mecum.*

made by the observers from day to day, and the registers in their finished form have now been awaiting discussion for nearly three years. At the request of Mr. Blanford, I undertook to discuss them during my incumbency of the office of Meteorological Reporter to the Government of India, in the beginning of this year (1885), and hence the results are now published by me, though they belong to a station not in my province.

Air Temperature.

During the greater part of the four years, observations of the dry and wet bulb thermometers were made three times daily, namely, at 5-45 A.M., 1-45 P.M., and 9-45 P.M.; but, for the first two and a half months, they were made at 6 A.M., 12 noon, and 6 P.M. For the sake of uniformity, interpolated mean values for these months have been given in the table, the interpolation being easily effected with sufficient accuracy, owing to the circumstance that standard observations of the thermometers under a shed were made daily at 6 A.M., 4 P.M., and 10 P.M., and that the respective differences between the monthly mean values of these and the $5\frac{3}{4}$ A.M., $1\frac{3}{4}$ P.M., and $9\frac{3}{4}$ P.M. observations of the thermometers in the upper or lower cages during the succeeding three years were nearly constant. The observations of the maximum and minimum thermometers in each cage were made once a day. For the first three months these served in some degree to check the interpolated values for $5\frac{3}{4}$ A.M. and $1\frac{3}{4}$ P.M.

During the greater part of the time, however, the observations of the self-registering thermometers in the upper cage, especially those of the maximum, were frequently as much as 5, 10, 15, or even 20 degrees in error. In some cases this may have been due to the sunshine reaching the instruments in spite of all precautions against it, but in most I think it was only an effect of the state of trepidation in which the observer found himself at such an unaccustomed altitude. The self-registering thermometers, being read last, would be most affected by the observer's nervousness, which seems always to have had the effect of adding to or subtracting from the true reading some multiple of five degrees,—that is, of one of the large divisions of the scale.[1]

These observations I have freely corrected wherever I judged it necessary, the guide for the minimum being the observation at 5-45 A.M., and that for the maximum the observation at 1-45 P.M. The daily extremes for the upper cage as given in the table must, however, be considered doubtful.

Table I.—*Air Temperature.*

January.

Year.	Lower cage—4 feet.						Upper cage—40 feet.					
	$5\frac{3}{4}$ h.	$13\frac{3}{4}$ h.	$21\frac{1}{4}$ h.	Mean.	Maximum.	Minimum.	$5\frac{3}{4}$ h.	$13\frac{3}{4}$ h.	$21\frac{1}{4}$ h.	Mean.	Maximum.	Minimum.
1879 .	54·3	78·7	59·2	64·3	82·1	52·9	57·4	77·1	63·4	66·2	80·2	56·9
1880 .	56·4	79·0	60·5	65·5	82·0	55·2	58·4	77·1	63·3	66·5	80·3	58·0
1881 .	52·4	77·3	56·5	62·3	80·8	51·1	55·9	75·4	60·4	64·1	77·6	54·6
1882 .	58·3	80·3	62·4	67·2	83·7	55·8	60·3	78·9	66·3	68·7	81·8	58·4
Mean	55·3	78·8	59·7	64·8	82·2	53·7	58·0	77·4	63·3	66·4	80·0	5 7·

[1] Most of these occur in the summer months, when the sun's place at sunset had a considerable northern azimuth. The tin side-screen originally provided for the cage was not wide enough, and there is no doubt that the majority of the erroneous readings of the maximum were due to sunshine.—H. F. B.

FEBRUARY.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.
1879.	62·1	84·5	67·4	71·6	83·1	60·3	64·0	83·0	69·9	72·8	85·8	63·4
1880.	61·7	81·7	65·9	70·1	85·4	60·5	62·4	80·0	67·7	70·5	83·5	62·0
1881.	61·6	86·5	66·5	71·8	89·6	59·8	63·6	84·3	69·1	72·8	87·3	62·4
1882.	60·4	82·6	65·2	69·7	86·2	58·3	62·1	81·2	66·6	70·5	84·3	59·7
Mean	61·4	83·8	66·3	70·8	87·8	59·7	63·0	82·1	68·3	71·6	85·2	61·9

MARCH.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.
1879.	70·3	93·3	74·8	79·9	96·8	69·2	71·8	91·5	76·3	80·3	94·4	71·5
1880.	69·7	91·0	74·1	78·7	93·9	68·7	70·4	89·6	75·1	78·8	91·8	69·9
1881.	67·4	87·7	72·0	76·1	90·9	66·6	68·5	86·4	73·0	76·4	89·4	67·9
1882.	70·7	94·6	76·4	81·0	97·4	68·4	72·0	93·3	77·0	81·1	96·3	69·6
Mean	69·5	91·6	74·3	78·9	94·7	68·2	70·7	90·2	75·3	79·1	93·0	69·7

APRIL.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.
1878.	75·9	94·7	79·3	83·6	97·5	75·0	76·3	93·6	79·9	83·7	96·2	75·8
1879.	78·2	99·2	81·5	86·6	102·2	77·1	78·7	97·6	82·0	86·5	99·6	78·1
1880.	76·6	94·5	79·0	83·7	97·6	75·6	76·8	93·5	79·9	83·8	96·2	76·2
1881.	76·4	98·1	80·2	85·2	100·5	75·8	76·9	96·7	80·5	85·1	99·4	76·0
Mean	76·8	96·6	80 0	84·8	99·4	75·9	77·1	95·4	80·6	84·8	97·9	76·5

May.

Year.	Lower cage—4 feet.						Upper cage—40 feet.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.
1878 .	76·2	92·7	77·8	82·3	97·5	73·8	76·6	91·3	78·4	82·8	96·4	74·1
1879 .	80·7	96·2	83·1	87·4	100·3	80·0	81·0	94·3	83·2	86·9	97·6	80·4
1880 .	76·8	92·9	78·3	83·4	97·8	75·0	77·0	91·9	78·4	83·1	96·6	75·5
1881 .	77·7	93·5	80·1	84·5	97·1	76·6	78·1	92·9	80·6	84·6	94·8	76·0
Mean	77·9	93·8	79·8	84·5	98·2	76·4	78·2	92·6	80·1	84·3	96·4	76·5

June.

Year.	Lower cage—4 feet.						Upper cage—40 feet.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.
1878 .	82·3	95·1	82·7	86·9	98·4	80·0	82·7	94·8	82·9	87·1	97·4	80·5
1879 .	80·0	92·1	81·1	84·6	95·6	78·9	80·2	90·2	81·4	84·2	94·2	79·3
1880 .	80·2	88·2	80·9	83·3	92·8	78·8	80·3	87·2	81·1	83·2	91·9	78·9
1881 .	79·6	88·1	80·7	83·0	92·9	78·5	79·6	87·2	80·8	82·8	91·2	78·3
Mean	80·5	90·9	81·4	84·5	94·9	79·0	80·7	89·8	81·5	84·3	93·7	79·2

July.

Year.	Lower cage—4 feet.						Upper cage—40 feet.					
	5½ h.	13½ h.	21½ h.	Mean.	Maximum.	Minimum.	5½ h.	13½ h.	21½ h.	Mean	Maximum.	Minimum.
1878 .	79·8	88·4	81·0	83·4	93·4	79·2	80·7	87·5	81·4	83·4	92·2	80·1
1879 .	78·5	88·6	79·8	82·5	92·7	77·7	78·6	87·8	80·0	82·3	91·6	78·1
1880 .	78·8	89·4	80·0	82·9	92·9	77·4	78·7	88·4	80·3	82·7	91·4	77·6
1881 .	79·6	87·3	80·7	82·7	91·0	76·4	79·6	86·1	80·8	82·4	89·3	76·2
Mean	79·2	88·4	80·4	82·9	92·5	77·7	79·4	87·4	80·6	82·7	91·1	78·0

AUGUST.

YEAR.	LOWER CAGE—4 FEET.						UPPER CAGE—40 FEET.					
	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.
1878 .	79·4	88·0	80·9	83·1	92·0	78·6	79·6	87·1	81·2	82·9	90·5	79·1
1879 .	78·2	87·4	80·0	82·2	92·2	77·7	78·4	85·9	80·2	81·8	90·6	78·0
1880 .	79·1	87·3	80·2	82·7	90·9	78·2	79·4	86·6	80·2	82·4	89·6	78·5
1881 .	79·0	86·3	80·4	82·2	90·1	77·6	79·0	85·1	80·0	81·7	88·4	77·5
Mean .	78·9	87·4	80·4	82·5	91·8	78·0	79·1	86·2	80·4	82·2	89·8	78·3

SEPTEMBER.

YEAR.	LOWER CAGE—4 FEET.						UPPER CAGE—40 FEET.					
	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.
1878 .	79·3	87·8	80·7	82·8	93·5	78·4	79·5	87·2	81·1	82·7	91·4	79·0
1879 .	78·7	87·3	79·9	82·2	92·5	77·9	79·0	86·1	80·2	81·9	90·6	78·7
1880 .	77·4	86·1	79·2	81·1	91·7	76·6	77·8	85·0	79·6	80·9	90·5	77·2
1881 .	79·0	88·6	79·9	82·7	92·1	77·9	79·4	87·6	80·0	82·4	90·7	78·0
Mean .	78·6	87·5	79·9	82·2	92·5	77·7	78·9	86·5	80·2	82·0	90·8	78·2

OCTOBER.

YEAR.	LOWER CAGE—4 FEET.						UPPER CAGE—40 FEET.					
	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.
1878 .	76·0	88·3	77·6	81·0	92·7	75·3	77·1	87·4	78·7	81·4	91·1	76·8
1879 .	75·8	88·0	77·2	80·7	91·6	75·2	76·3	86·7	77·8	80·6	89·4	75·9
1880 .	75·8	87·3	77·3	80·5	92·3	75·0	76·1	86·1	78·0	80·4	90·5	76·0
1881 .	73·3	88·1	75·9	79·5	92·0	72·8	74·9	86·9	77·2	80·0	89·9	74·1
Mean .	75·2	87·9	76·9	80·4	92·1	74·6	76·1	86·8	77·9	80·6	90·2	75·7

NOVEMBER.

YEAR.	LOWER CAGE—4 FEET.						UPPER CAGE—40 FEET.					
	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.	6¼ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.
1878.	68·6	82·8	69·8	74·9	86·9	66·9	69·6	82·0	72·4	74·9	85·0	69·2
1879.	62·7	81·7	65·9	70·4	84·9	61·8	64·6	80·6	68·6	71·5	83·0	64·4
1880.	64·5	81·8	67·0	71·4	85·5	63·7	66·3	80·7	69·2	72·3	84·2	66·1
1881.	62·6	83·3	66·5	71·1	85·7	61·7	64·4	81·8	68·6	71·8	83·3	64·0
Mean	64·6	82·4	67·3	71·7	85·8	63·5	66·2	81·3	69·7	72·6	83·9	65·9

DECEMBER.

YEAR.	LOWER CAGE—4 FEET.						UPPER CAGE—40 FEET.					
	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.	5¾ h.	13¾ h.	21¾ h.	Mean.	Maximum.	Minimum.
1878.	58·2	76·8	60·6	65·4	79·7	56·9	60·1	75·6	64·1	66·8	77·8	59·3
1879.	55·4	76·5	58·5	63·7	80·1	54·3	57·6	74·9	62·0	68·0	78·4	57·2
1880.	54·1	76·2	58·1	63·0	79·4	53·8	57·0	75·0	61·5	64·7	76·6	56·2
1881.	53·6	77·4	57·7	63·1	80·0	52·6	57·2	75·7	58·9	64·1	77·8	56·0
Mean	55·3	76·7	58·7	63·8	79·8	54·4	58·0	75·3	61·6	65·2	77·7	57·2

The mean temperatures in Table I have been obtained in the following way. Two methods of finding a first approximation to the mean for the 24 hours are immediately suggested by the observations, the first being the arithmetical mean of the maximum and minimum, and the other that of the three observations of the dry-bulb thermometer at equidistant intervals. Both of these methods are in common use for places where the form of the diurnal curve is unknown.

On trying these methods it was found that they yielded results which differed in most months by 3° or more, the mean of the maximum and minimum being the higher, whilst the difference was usually rather greater for the lower cage than for the upper. To determine which of the two methods of arriving at the mean should be adopted, I took the published measurements of the thermograph traces of the Alipore observatory for the years 1880 and 1881, and in their mean values for each month, inserted, under the proper hours, the means in the first three columns of Table I, first for the lower cage and afterwards for the higher, altering proportionately the figures for the intervening hours. The resulting hourly means were then taken to represent the true diurnal variation of temperature in the exposed cages at 4 feet and 40 feet above the ground.

The corrections to be applied to the means of three equidistant observations at the hours mentioned in order to reduce them to the true diurnal mean were found to be the following :—

Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Lower cage .	+0·2	+0·3	+0·4	+0·3	+0·7	+0·2	+0·2	+0·3	+0·2	+0·4	+0·3	+0·2
Upper cage .	+0·2	+0·5	+0·4	+0·4	+0·7	+0·3	+0·2	+0·3	+0·1	+0·3	+0·2	+0·2

The hourly means have been charted on Plate XXIX, where it will be seen that there is a considerable difference in form between the dotted curves, which represent the variation at 40 feet above the ground, and the continuous curves which refer to the lower station, 4 feet above the ground. In the first place, the range is less at the upper cage in all months of the year, the maximum not being so high, nor the minimum so low, as in the lower cage. The difference during the night hours appears to be nearly constant, but this is probably because there are no observations between $9\frac{3}{4}$ P.M. and $5\frac{3}{4}$ A.M.; the epochs of minimum seem to be almost identical, but those of maximum differ considerably in some of the months. In June, July, August, September, and October, the months of the strong southerly or south-easterly winds of the "monsoon," the maximum epochs are the same; but in the remaining months, when the winds are westerly, and particularly in the cold season, when they are very light, the maximum at the upper cage is considerably retarded.

The following table gives the difference of temperature between the two cages at each hour of observation, also the difference of the means and of the maxima and minima, the latter being subject to some doubt on account of the errors of observation above mentioned.

Table II.—*Mean Difference of Temperature (Upper minus Lower Cage) for each month in the year.*

Month.	$5\frac{1}{2}$ hours.	$13\frac{1}{2}$ hours.	$21\frac{1}{2}$ hours.	Mean.	Maximum.	Minimum.
January .	2·7	—1·4	3·6	1·6	—2·2	3·3
February .	1·6	—1·7	2·0	0·8	—2·1	2·2
March .	1·2	—1·4	1·0	0·2	—1·7	1·5
April .	0·3	—1·2	0·6	0·0	—1·5	0·6
May .	0·3	—1·2	0·3	—0·2	—1·8	0·1
June .	0·2	—1·1	0·1	—0·2	—1·2	0·2
July .	0·2	—1·0	0·2	—0·2	—1·4	0·3
August .	0·2	—1·2	0·0	—0·3	—2·0	—0·3
September	0·3	—1·0	0·3	—0·2	—1·7	0·5
October .	0·9	—1·1	1·0	0·2	—1·9	1·1
November	1·6	—1·1	2·4	0·9	—1·9	2·4
December .	2·7	—1·4	2·9	1·4	—2·1	2·8
Mean .	1·02	—1·23	1·20	0·33	—1·79	1·28

The self-registered extremes are subject to some doubt, as above explained, hence their differences, especially those of the maxima, which are most doubtful, cannot be expected to exhibit any regular annual variation. In the columns for the several hours of observation and for the mean, a very regular annual variation is apparent, the excess temperature of the upper cage in the night hours and in the early morning, and its defect at mid-day, being greatest in the cold season and least in the middle of the rains. The mean temperature, at 40 feet above the ground, is higher than at 4 feet in the cold season and lower in the hot, but the difference in the former season is much greater than in the latter; consequently the mean for the year is a third of a degree higher above than below.

At first sight, this vertical distribution of the mean temperature appears contrary to the principles of physics, as well as to the universal experience that, on the whole, temperature decreases on ascending; but on further consideration I think it will be found to contravene no physical law.

The "law of convective equilibrium," according to which the upper cage should be about 0·2° F. cooler than the lower, presupposes that the air is moving more or less upwards or downwards. An approximation to the law is the rule in nature on the large scale,—that is to say, when we compare places with a considerable difference of elevation. But exceptions to the law are constantly observed; the most frequent being the distribution of temperature observed in anti-cyclones when the sky is clear; under which circumstances, it is well known that stations near sea-level are often colder than those on mountain sides. Another exceptional condition, frequently observed in hot countries, is that which gives rise to the *mirage*, the layers of air near the ground being, in this case, heated until the temperature difference between them and layers a few feet higher is many times greater than it could be under conditions of convection.

At Alipore, the mean velocity of the wind as measured by an anemometer 52 feet above the ground is as follows :—

Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Velocity, miles per hour . .	3	4	6	8	7	6	5	5	5	3	3	3

Near the ground, owing to the obstruction caused by buildings and trees, and to friction against the ground surface, the velocity is doubtless very much less. The conditions, under which the law of convective equilibrium approximately holds good, are therefore very seldom met with, but more frequently obtained in the months March to September, inclusive, than in the cold season. During the nights of the cold weather, in fact, there is usually no sensible movement of the air near the ground surface.

The differences in Table II are quite in accordance with what might be expected to follow from these conditions. In the hot season, all the differences are less than in the cold, because the wind velocity is greater, and portions of the air from different altitudes are constantly being mixed up. In the hot season, when the day is longer than the night, and the absorption of solar heat by the ground is greater than the loss by radiation into space, the mean temperature of the air in the lower cage is somewhat higher than in the upper. On the other hand, in the cold season, when the nights are long and nocturnal radiation is most effective, we find the temperature at 40 feet

elevation the higher of the two; and the difference of the means is greater than in the hot season, because, in the night time, when the lower cage is normally the cooler, there is hardly any wind; whereas, in the day time, the wind prevents the lower thermometers from becoming much warmer than the upper.

In consequence of the relative stillness of the air, at those hours and seasons of the diurnal and annual periods when the upper cage is normally the warmer, we find that the positive differences in Table II exceed the negative on the average of the year, or that the upper cage is somewhat the hotter. To what height this relation extends is not known, but presumably it does not extend very far. Further observations from other stations and at greater elevations above the ground would be useful in elucidating this point.

On searching through the registers for the greatest differences of temperature between the upper and lower cages, it is found that they always occur in the cold season, on days when the sky is clear and there is very little wind, whilst, on windy and cloudy days, the differences are small and are sometimes reversed in direction. The greatest differences noted at the hours of observation were the following:—

Hour.	Difference, Upper—Lower.	Date.
$5\frac{3}{4}$.	+7·5 degrees.	25th January 1879.
$13\frac{3}{4}$.	—4·7 „	15th February 1879.
$21\frac{1}{4}$.	+8·8 „	23rd January 1882.

Some part of the difference between the two cages may perhaps be due to radiation between the ground or sky and the thermometers, through the open front of the cage; though, theoretically, such radiation, if we neglect the absorption of a layer of air 36 feet thick, ought to affect both sets of thermometers equally. At all events, radiation must have affected the instruments in the lower cage, in such a manner as to increase considerably both the diurnal and annual range of temperature, while leaving the annual mean unchanged. This will be seen from the next two tables.

TABLE III.—*Monthly Mean Temperatures. Average of four years.*

Month.	Under shed.	Lower cage.	Upper cage.
January .	65·9°	64·8°	66·4°
February .	71·3	70·8	71·6
March . .	78·9	78·9	79·1
April . .	84·6	84·8	84·8
May . .	83·8	84·5	84·3
June . .	84·1	84·5	84·3
July . .	82·1	82·9	82·7
August . .	81·8	82·5	82·2
September .	81·7	82·2	82·0
October . .	80·0	80·4	80·6
November .	72·4	71·7	72·6
December .	64·9	63·8	65·2
Year . .	77·63	77·65	77·99

TABLE IV.—*Daily Ranges of Temperature. Average of four years.*

MONTH.	Under shed.	Lower cage.	Upper cage.	DIFFERENCE OF 13¾ AND 5¾ h.	
				Lower.	Upper.
January .	22·2°	28·5°	23·0°	23·5°	19·4°
February .	21·8	27·6	23·3	22·4	19·1
March .	21·2	26·5	23·3	22·1	19·5
April .	18·9	23·5	21·4	19·8	18·3
May .	16·4	21·8	19·9	15·9	14·4
June .	11·5	15·9	14·5	10·4	9·1
July . .	10·0	14·8	13·1	9·2	8·0
August .	9·4	13·8	11·5	8·5	7·1
September .	9·5	14·8	12·6	8·9	7·6
October .	11·7	17·5	14·5	12·7	10·7
November .	16·6	22·3	18·0	17·8	15·1
December .	20·2	25·4	20·5	21·4	17·3
Year . .	15·8	21·0	18·0	16·1	13·8

From Table III it will be seen that, in the cold-weather months, the true air temperature, as given by thermometers under a thatched shed, is intermediate between those indicated by the thermometers in the upper and lower cages, while, from April to October, inclusive, the true mean temperature is lower than that given by either of the cages. On the average of the year, however, the thermometers in the lower cage and under the shed agree exactly.

As regards the diurnal range, Table IV shows that the self-registering instruments, in both of the exposed cages, give a much greater range than those under the shed, as was to be expected. Some of the self-registered extremes being of doubtful accuracy, the differences between the early morning and early afternoon observations have been inserted in the last two columns of Table IV, on the supposition that their ratios will be the same as those of the true daily ranges. These ratios, estimated from both sets of data, are as follow:—

MONTH.	RATIOS OF DAILY RANGES, UPPER÷LOWER.	
	From extremes.	From morning and afternoon observations.
January . .	·81	·83
February . .	·85	·85
March . .	·88	·88
April . .	·90	·92
May . .	·91	·91
June . .	·91	·88
July . .	·88	·87
August . .	·83	·84
September . .	·85	·85
October . .	·83	·84
November . .	·81	·85
December . .	·81	·81
Year . .	·86	·86

The two series agree fairly and give the same mean result, but the latter is the more regular, as was to be expected. On comparing this series with the table of wind velocities on page 456, it is seen that when there is most wind the ratio approaches most nearly to unity, and becomes least when the wind velocity is a minimum. This confirms the reasoning, above given, to account for the differences observed between the two sets of thermometers at each hour of observation.

Absolute Humidity.

Observations of the wet-bulb thermometers, taken at the regular hours, combined with those of the dry, enable us to determine the absolute and relative humidity of the air in each cage by the application of the usual psychrometric formula. Readings of a minimum wet bulb instrument in each cage were also made, apparently as a check upon the $5\frac{3}{4}$ A.M. observations, and from these, in combination with the dry minima, humidities have been computed, though there is no certainty that the two minima occurred simultaneously. These results are printed for comparison in the tables below, but they have not been used in striking the daily means.

The vapour tensions computed from the individual observations by Regnault's modification of August's formula are given in Table V.

Table V.—*Vapour Tension.*

January.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¼ h.	13¾ h.	21¼ h.	Mean.	From Minima.	5¾h	13¾ h.	21¼ h.	Mean.	From Minima.
1879	·410	·390	·454	·418	·370	·420	·354	·453	·409	·401
1880	·435	·419	·472	·442	·409	·441	·393	·475	·436	·406
1881	·369	·345	·414	·378	·333	·368	·300	·402	·363	·363
1882	·461	·465	·509	·478	·434	·481	·446	·488	·472	·445
Mean	·419	·405	·462	·429	·387	·428	·373	·455	·420	·404

February.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¼ h.	Mean.	From Minima.	5¼ h.	13¾ h.	21¼ h.	Mean.	From Minima.
1879	·537	·463	·558	·519	·484	·550	·428	·553	·510	·492
1880	·508	·498	·544	·517	·463	·514	·482	·547	·514	·474
1881	·518	·437	·553	·503	·437	·516	·371	·535	·473	·489
1882	·475	·490	·523	·496	·428	·466	·459	·501	·475	·415
Mean	·509	·472	·544	·509	·453	·511	·435	·534	·493	·467

March.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1879 .	·680	·498	·708	·629	·607	·690	·460	·707	·619	·572
1880 .	·698	·666	·732	·699	·664	·708	·630	·733	·690	·624
1881 .	·633	·562	·654	·616	·605	·638	·506	·649	·598	·577
1882 .	·708	·551	·734	·664	·618	·711	·525	·726	·654	·605
Mean .	·680	·569	·707	·652	·624	·687	·530	·704	·640	·595

April.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	·815	·717	·834	·789	·778	·815	·688	·831	·778	·770
1879 .	·900	·739	·915	·851	·848	·916	·719	·919	·851	·843
1880 .	·852	·845	·847	·848	·808	·851	·803	·844	·833	·771
1881 .	·865	·714	·903	·827	·802	·862	·660	·891	·804	·779
Mean .	·858	·754	·875	·829	·809	·861	·717	·871	·816	·791

May.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	·836	·806	·817	·820	·757	·837	·769	·815	·807	·747
1879 .	·939	·882	·944	·922	·880	·946	·872	·951	·923	·889
1880 .	·861	·852	·839	·851	·790	·858	·810	·835	·834	·742
1881 .	·880	·892	·877	·883	·846	·873	·832	·866	·857	·829
Mean .	·879	·858	·869	·869	·818	·879	·821	·867	·855	·802

JUNE.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	·998	1·008	·984	·997	·923	1·001	·987	·990	·993	·911
1879 .	·966	·972	·942	·960	·866	·971	·935	·954	·953	·879
1880 .	·983	·994	·981	·986	·922	·976	·985	·974	·978	·879
1881 .	·967	·987	·958	·971	·913	·959	·953	·954	·955	·899
Mean .	·978	·990	·966	·978	·906	·977	·965	·968	·970	·892

JULY.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h	13½ h.	21½ h.	Mean.	From Minima.
1878 .	·974	1·009	·986	·990	·949	·981	·987	·991	·986	·942
1879 .	·936	·964	·952	·951	·886	·943	·938	·954	·948	·886
1880 .	·951	·990	·943	·961	·882	·949	·950	·940	·946	·860
1881 .	·962	1·003	·975	·980	·919	·952	·961	·966	·960	·920
Mean .	·956	·992	·964	·971	·909	·956	·959	·963	·960	·902

AUGUST.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	·967	·997	·980	·981	·932	·972	·985	·983	·980	·915
1879 .	·941	·973	·957	·957	·882	·947	·947	·954	·949	·882
1880 .	·959	·999	·962	·973	·915	·961	·963	·958	·961	·877
1881 .	·955	·999	·972	·975	·904	·950	·958	·959	·956	·906
Mean .	·955	·992	·968	·972	·908	·957	·963	·964	·961	·895

SEPTEMBER.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.
1878 .	·969	·995	·986	·983	·935	·982	·967	·990	·980	·933
1879 .	·948	·972	·967	·962	·895	·957	·936	·964	·952	·900
1880 .	·911	·946	·934	·930	·866	·919	·906	·934	·920	·853
1881 .	·955	·959	·957	·957	·908	·955	·933	·948	·945	·907
Mean .	·946	·968	·961	·958	·901	·953	·935	·959	·949	·898

OCTOBER.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.
1878 .	·876	·859	·895	·877	·844	·904	·818	·899	·874	·847
1879 .	·849	·851	·872	·857	·817	·854	·813	·863	·843	·799
1880 .	·874	·876	·899	·883	·829	·888	·843	·896	·876	·800
1881 .	·820	·777	·848	·815	·781	·822	·734	·834	·797	·777
Mean .	·855	·841	·878	·858	·818	·867	·802	·873	·847	·806

NOVEMBER.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.	5¼ h.	13¼ h.	21¼ h.	Mean.	From Minima.
1878 .	·657	·652	·694	·668	·640	·671	·613	·690	·658	·636
1879 .	·512	·482	·555	·516	·497	·504	·448	·542	·498	·483
1880 .	·581	·556	·627	·588	·561	·586	·528	·621	·578	·547
1881 .	·524	·480	·585	·530	·501	·522	·466	·549	·512	·490
Mean .	·568	·543	·615	·575	·550	·571	·514	·600	·562	·539

DECEMBER.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	15½ h.	21½ h.	Mean.	From Minima.
1878 .	·441	·441	·482	·455	·405	·440	·427	·470	·446	·422
1879 .	·407	·402	·451	·420	·387	·404	·373	·452	·410	·387
1880 .	·398	·419	·447	·421	·369	·408	·378	·442	·409	·395
1881 .	·391	·414	·436	·414	·381	·394	·386	·421	·400	·377
Mean .	·409	·419	·454	·427	·385	·411	·391	·446	·416	·395

In the column of means has been entered the simple arithmetical mean of the three observations. The hourly means of vapour tension, computed from the thermograph traces of the observatory, show that the mean of the 6 h., 14 h., and 22 h. observations is slightly below the mean of the twenty-four hours in every month of the year; but the differences are so small that it is hardly worth while making corrections for them as regards the lower cage; while as regards the upper, it is likely that such corrections would not be applicable, because the diurnal curve there is probably very different in form from what it is near the ground. The actual differences between the means of three observations and the true diurnal mean are as follow :—

MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Difference .	·007	·004	·006	·008	·009	·006	·004	·003	·005	·011	·011	·008

In Table VI, the differences of vapour tension between 4 and 40 feet above the ground are given for each hour of observation, and in Table VII the general means derived from observations of the thermometers in the two cages and those under a shed are compared.

TABLE VI.—*Mean Differences of Vapour Tension (Upper minus Lower Cage).*

MONTH.	5½ h.	13½ h.	21½ h.
January .	+·009	—·032	—·007
February .	+·002	—·037	—·010
March . .	+·007	—·039	—·004
April . .	+·003	—·037	—·004
May . .	·0	—·037	—·002
June . .	—·001	—·025	+·002
July . .	·0	—·033	—·001
August . .	+·002	—·029	—·004
September .	+·007	—·033	—·002
October . .	+·012	—·039	—·006
November . .	+·003	—·029	—·015
December .	+·002	—·028	—·008
Year . .	+·004	—·033	—·005

TABLE VII.—*Monthly and Annual Means of Vapour Tension. Average of 4 years.*

MONTH.	Under shed.[1]	Lower cage.	Upper cage.
January .	·428	·429	·420
February .	·510	·509	·493
March .	·663	·652	·640
April .	·837	·829	·816
May .	·886	·869	·855
June .	·978	·978	·968
July .	·968	·971	·960
August .	·971	·972	·961
September .	·957	·958	·949
October .	·855	·858	·847
November .	·570	·575	·562
December .	·427	·427	·416
Year . .	·754	·752	·741

From these tables it appears that, while there is a very close agreement between the tensions of vapour under the thatched shed and in the lower cage, except in the months of March, April, and May, there is a very considerable deficiency at the upper cage; the average difference being so great, or the ratio of the upper to the lower value of the vapour pressure differing so considerably from unity, that if the same rate of diminution continued, the vapour pressure would be reduced one-half on ascending through about 1,700 feet. Now, on the hypothesis of an independent vapour atmosphere, this condition should be attained at a height of some 29,000 feet, while observations made on mountains and during balloon ascents prove that it is actually attained at 6,500 or 7,000 feet. It is evident, therefore, that there is something unreal or exceptional about the rate of diminution given by these observations.

We have only to look at Table VI to see that, while the $5\frac{3}{4}$ h. and $21\frac{3}{4}$ h. observations give indications of a diurnal up and down movement of vapour, which, on the average of each month, as well as of the whole year, would leave hardly any perceptible difference between the means for two points at 36 feet vertical distance, there is, in the afternoon, some cause at work which produces a great apparent deficiency of vapour at the higher point. To the same cause is doubtless to be attributed the defect shown by the lower cage observations, as compared with those made under a shed in the months of March, April, and May.

This cause is nothing but the wind. In Regnault's psychrometric formula, as in others, it is assumed that the air around the wet-bulb thermometer is constantly changed,

[1] Published mean values *minus* the quantities given on page 463.

the air arriving with the normal humidity and at the temperature of the dry bulb, and going away saturated at the temperature of the wet bulb.

From these assumptions it can be shown that the quantity to be deducted from the pressure of saturated vapour at the temperature of the wet bulb in order to find the actual vapour pressure is—

$$\frac{s}{d}\frac{(t-t')\,h}{L}$$

L standing for the latent heat of evaporation, t and t' for the observed temperatures, h for the height of the barometer, s for the specific heat of air, and d for the density of vapour compared to air. The first factor of the numerator is nearly constant and equal to ·2375 ÷ ·622, or to ·38. Regnault found, however, that when he used the formula with this constant, the humidities deduced were always too high; therefore, while retaining the same formula, he empirically increased the constant to ·48, when he found it gave results in fair accordance with those found by a chemical hygrometer.

The reason why Regnault's constant had to be increased is doubtless that, under ordinary conditions, the assumption of the constant renewal of the air is not justified; therefore a larger deduction has to be made from the tabular vapour tension at the wet-bulb temperature than is indicated by theory. It is evident, therefore, that if the formula with the modified constant gives correct results for the relatively still air under the shed, it must give too low results for the open cages at those hours of the day and in those months of the year when a strong wind is blowing. And since, when any wind is blowing, it is always stronger at the top of a 40-foot pole than near the ground surface, we find a considerable defect at the upper cage as compared with the lower; especially in the afternoons when the wind is strongest.

The general conclusion to be drawn from these observations is, that they teach us little or nothing about the vertical movements of vapour, the difference of elevation being too small.

Relative Humidity.

Relative humidities or percentages of saturation have been computed from the individual observations of the dry and wet bulbs. Their means are here printed in Table VIII.

Table VIII.—*Relative Humidity.*

January.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1879 .	96	40	90	75	91	88	38	77	68	86
1880 .	93	42	89	75	92	89	43	81	71	83
1881 .	91	37	89	72	87	81	34	76	64	83
1882 .	93	46	89	76	93	90	45	75	70	90
Mean .	93	41	89	74	91	87	40	77	68	86

FEBRUARY.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1879 .	96	39	83	73	91	91	37	74	67	84
1880 .	92	46	84	74	83	89	47	79	72	84
1881 .	89	35	84	69	83	84	31	75	63	86
1882 .	89	44	83	72	87	83	43	75	67	81
Mean .	91	41	84	72	86	87	40	76	67	84

MARCH.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1879 .	90	31	80	67	83	86	31	77	65	75
1880 .	94	45	84	74	91	93	44	82	73	83
1881 .	94	45	83	74	92	91	42	79	71	85
1882 .	93	34	80	69	88	89	34	77	67	83
Mean .	93	39	82	71	88	90	38	79	69	82

APRIL.

YEAR.	LOWER CAGE—4 FEET.					UPPER CAGE—40 FEET.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	91	44	84	73	90	90	43	82	72	87
1879 .	93	41	85	73	91	93	42	84	73	87
1880 .	93	52	85	77	90	92	52	84	76	85
1881 .	95	40	87	74	89	93	39	85	72	85
Mean .	93	44	85	74	90	92	44	84	73	86

MAY.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	92	54	86	77	90	91	53	84	76	88
1879 .	90	53	83	75	86	89	56	83	76	86
1880 .	93	56	86	78	90	91	54	85	77	83
1881 .	91	58	85	78	92	90	54	83	76	90
Mean .	91	55	85	77	90	90	54	84	76	87

JUNE.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	92	61	88	80	91	91	60	88	80	87
1879 .	94	66	89	83	87	98	63	88	83	87
1880 .	96	75	93	88	93	95	74	91	87	89
1881 .	96	75	91	87	93	94	74	90	86	93
Mean .	95	69	90	85	91	95	68	89	84	89

JULY.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	96	76	93	88	95	95	75	92	87	92
1879 .	96	72	93	87	93	97	72	93	87	92
1880 .	97	71	92	87	94	96	71	91	86	91
1881 .	95	78	93	89	93	94	77	92	88	94
Mean .	96	74	93	88	94	95	74	92	87	92

AUGUST.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	93	76	93	87	95	92	75	92	86	92
1879 .	97	75	93	88	93	97	75	92	88	92
1880 .	96	76	93	88	95	95	75	93	88	90
1881 .	96	80	93	90	95	96	78	92	89	95
Mean .	95	77	93	88	95	95	76	92	88	92

SEPTEMBER.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	97	76	94	89	96	97	75	93	88	94
1879 .	96	76	95	89	94	97	73	93	88	92
1880 .	97	76	93	89	94	97	75	92	88	91
1881 .	96	71	94	87	95	95	72	91	86	94
Mean .	96	75	94	88	95	96	74	92	87	93

OCTOBER.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5¾ h.	13¾ h.	21¾ h.	Mean.	From Minima.	5¾ H.	13¾ h.	21¾ h.	Mean.	From Minima.
1878 .	97	65	94	85	96	96	63	91	83	91
1879 .	95	64	93	84	93	94	64	91	83	89
1880 .	98	68	95	87	95	97	68	93	86	91
1881 .	99	59	94	84	96	94	57	89	80	92
Mean .	97	64	94	85	95	95	63	91	83	91

NOVEMBER.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	6½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	93	58	94	82	94	91	55	85	77	87
1879 .	89	44	85	73	88	81	42	76	66	78
1880 .	94	51	94	80	93	89	50	86	75	84
1881 .	92	42	89	74	91	85	42	78	68	81
Mean .	92	49	90	77	91	87	47	81	72	83

DECEMBER.

Year.	Lower cage—4 feet.					Upper cage—40 feet.				
	5½ h.	13½ h.	21½ h.	Mean.	From Minima.	5½ h.	13½ h.	21½ h.	Mean.	From Minima.
1878 .	89	48	90	76	84	82	48	77	69	81
1879 .	92	44	91	76	91	84	45	81	70	83
1880 .	94	46	92	77	88	87	43	80	70	86
1881 .	93	44	91	76	95	83	43	84	70	83
Mean .	92	45	91	76	89	84	45	81	70	84

As the reduced measurements of the thermograph traces show that the mean humidity at 6 A.M., 2 P.M. and 10 P.M. does not differ more than 1 per cent. from the true mean of the day, the simple means of the three observations in Table VIII have been adopted as daily means.

The differences between the two stations at each hour of observation and on the mean of the day are given in the next Table.

TABLE IX.—*Differences of Relative Humidity (Upper minus Lower Cage).*

Month.	5½ h.	13½ h.	21½ h.	Mean.
January .	— 6	— 1	—12	— 6
February .	— 4	— 1	— 8	— 5
March .	— 3	— 1	— 3	— 2
April .	— 1	0	— 1	— 1
May . .	— 1	— 1	— 1	— 1
June . .	0	— 1	— 1	— 1

TABLE IX.—*Differences of Relative Humidity* (*Upper minus Lower Cage*)—contd.

Month.	5½ h.	13½ h.	21½ h.	Mean.
July . .	— 1	0	— 1	— 1
August .	0	— 1	— 1	0
September .	0	— 1	— 2	— 1
October .	— 2	— 1	— 3	— 2
November .	— 5	— 2	— 9	— 5
December .	— 8	0	—10	— 6
Year . .	— 3	— 1	— 4	— 3

In no instance is the mean humidity of the upper cage greater than that below, but in the middle of the day the two are nearly equal, the higher temperature near the ground diminishing the degree of saturation nearly as much as it is apparently decreased by the action of the wind upon the upper thermometers.

The greatest mean difference occurs in the cold weather and in the evening or early night hours, when the air near the ground is cooled by radiation, whilst at moderate elevations it is comparatively warm. Under these circumstances, as is well known to residents of Calcutta, the ground is frequently covered with a dense fog, while at the level of upper-storey windows the air is clear. The difference of humidity at this time sometimes amounts to 25 or 30 per cent. of saturation. In the rainy season, on the other hand, when there is usually more or less wind both night and day, the differences both of temperature and humidity are small.

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OF

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OF

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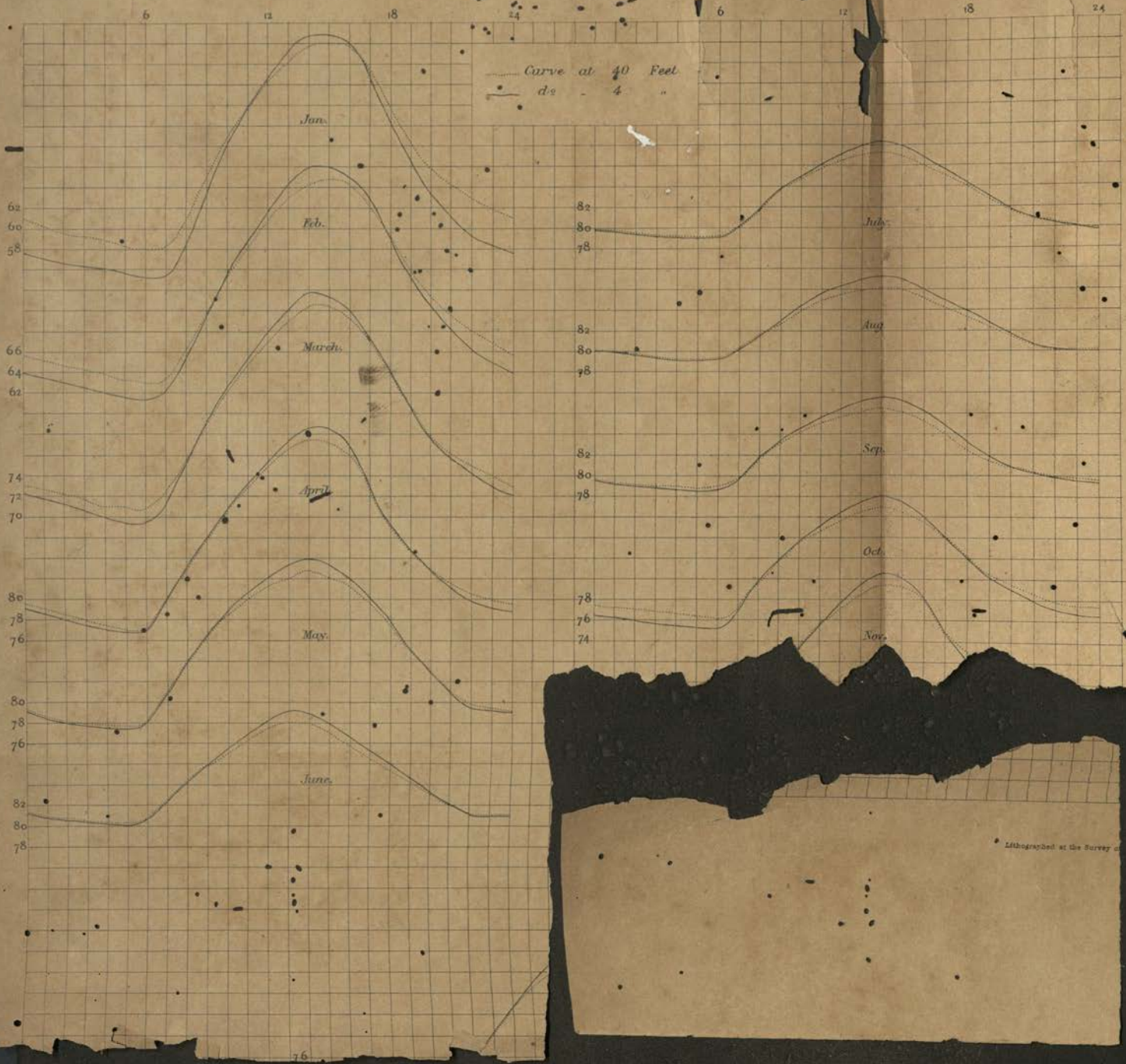
DIURNAL VARIATION OF TEMPERATURE AT HEIGHTS OF 4 FEET AND 40 FEET ABOVE THE GROUND AT ALIPORE.



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